CHEMICAL & METALLURGICAL ENGINEERING

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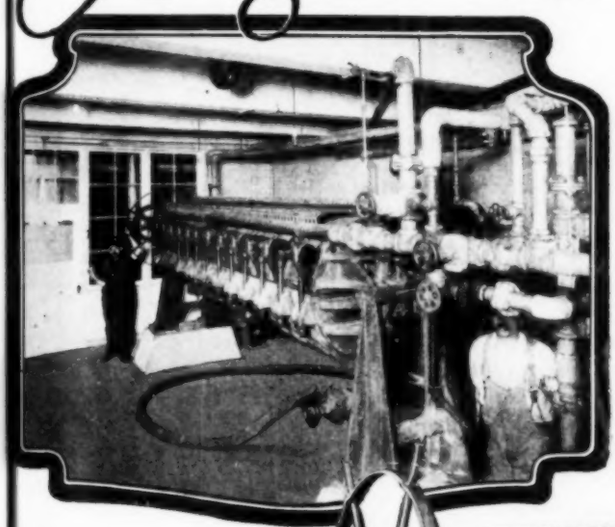

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A Lagging Public Conscience

THE other day we saw an advertisement of one of the most popular magazines which has a large circulation among intelligent and thinking people. In what follows we do not criticize its editorial policy; indeed when we find ourselves quoted in its columns we admit frankly that we like it. What disturbs us is that in looking for opinions as expressed in American journals and periodicals it evidently has missed something, and the reason is because what we have in mind isn't there. The advertisement reads, "If we join the League of Nations will it glorify us or destroy us? Shall we be able to 'readjust the affairs of civilization' or shall we 'surrender the republic'? Will (*sic*) we be safer in or out? Read both sides of the great national debate in . . ."

There we are! Shall we be glorified or injured or become the boss of all civilization or lose power, and how can we play for safety? How can we beat the game? Where does our advantage lie?

As a member of the great family of nations, if that is the substance of our interest, it indicates that we must be rather a mean brother. Or if we are a great business organization, it might almost be taken as a warning to look out for us. Every question has to do with jockeying for position, and not one touches our obligations or shows even an interest in how the other fellow is to live.

Now that does not represent the heart of the United States. It does not indicate the outcome of the Spanish war, the freedom of Cuba, or the intent of effort with Filipinos or Porto Ricans, irrespective of whether we have been successful in these efforts or not. We have no opinion to impose on our readers concerning the League of Nations; indeed a vote of our editorial staff would very likely show a considerable division of opinion on the subject, and we do not set up to be wise in the matter. International politics is not our *métier*. We merely claim that there is such a thing as a public conscience in this country. When we entered the great war we did so with a will, and we gave our best for a great human purpose and with no intent or thought of any gain at all. The fat profiteer at home does not detract from the glory of the silent heroes buried in France. The ideals were present among those who died and among those who fought and struggled and lived. The trouble is that having done a big and great thing we have called a halt, and that halt has entered into our souls. It almost seems as though, during the past two years, we had closed our minds to all consciousness of our obligations. We miss the idea in our newspapers, in our talk, in the air.

Now our obligations loom big, bigger than ever before. We hold a strategic position on the earth, we have the richest land and the advantage of long experience in self-government. This indicates intelligence among our people. But all this will not keep us complacent and warm and rich unless we make ourselves desired for what we are just as much as if not more than for what we have to spend or to sell. Every business man knows the value of a good name and that good names are not achieved by astute jockeying for position or by trickery of any kind. Of course we must take care of our own, and of course we have immense duties at home and with our own people. We are not pressing any specific reform in this discourse; we are merely noting the absence of even the semblance of thought about our obligations, anywhere. The splendid magazine to which we refer is not to blame for this, even though the editor may have given the advertising man a little too loose a rein. What the editor found in comment was doubtless correctly set forth. What he did not find is that consciousness of what we owe to one another and to all men which it were better for us to consider. We need to do this thing by way of insurance for the next generation.

What to Do With The Patent Office Bill

IT IS EXCEPTIONAL, if not unprecedented, for a conference committee of the Senate and House of Representatives to re-open public hearings on a bill referred to it for final consideration. Accordingly it is a matter of gratification to all concerned that plans have been perfected for hearings on the Nolan Patent Office bill, to which the Senate has attached a rider providing for patenting the inventions of Government employees and administration of such patents by the Federal Trade Commission. These hearings will be held January 5, so we are informed.

Two things should be urged upon the conference committee: First, the bill should be relieved of its rider relating to patenting the inventions of Government employees; and second, the provisions of the House of Representatives for enlarging the examining and clerical forces of the Patent Office, and increasing their salaries, should be sustained as against the reductions recommended by the Senate.

The Nolan bill should be relieved of its rider because the two things have nothing in common except that they relate to patents. The bill has to do with administrative conditions in the Patent Office, on which there is unanimity of opinion, while the rider relates to a question of policy on which there is a marked difference of opinion between representatives of industry and the Government. There can be no possible excuse for confusing the two ideas or combining them for legislative purposes.

The salaries of examiners and clerks in the Patent Office should be greatly increased and made commensurate with the technical ability required of incumbents of those positions. It was in 1848, we believe, that the

salaries of chief examiners and Congressmen were identical. Since that time Congress has not forgotten to increase the salaries of its members several hundred per cent but has been curiously neglectful of the Patent Office, recognizing its employees with only minor increases in salary. As it exists today the condition in the Patent Office is a discredit to Congress, as well as a cause of dissatisfaction to industry, and should be remedied immediately.

Economic Lessons From Other Countries

RECOGNIZING the truism that necessity is the mother of invention, we of the United States have good reason to study what is being done in other countries where the pinch of necessity is forcing intelligent and vigorous action. Unless or until we all recognize that the people of the United States were spoiled by the war we shall get nowhere. In February, 1916, Sir GEORGE PAISH in an elaborate article in the New York *Sun* said:

"The idea that the United States is deriving or can derive any advantage whatever from the war is a complete delusion. All that is happening to the advantage of your country is that it is suffering less than the belligerents as a result of this titanic conflict."

Since we afterward entered the war, we lost, according to Sir GEORGE'S philosophy, the advantage we enjoyed as non-combatants. It may be that the statement is not strictly true, but there is something in it—more than we have thus far recognized.

A common delusion has been that inasmuch as the war interrupted certain kinds of progress we fell just that far behind, and that hence we should be the better off afterward because we would make progress more rapidly so as to catch up. If such a thing could be done, why didn't we just resolve unanimously a quarter century ago to double our rate of progress and then go ahead and do it?

We are now under the necessity of doing harder and more efficient work or of suffering the consequences; but, being spoiled, we do not yet recognize the fact. It is quite appropriate, then, to consider what other countries, under necessity, have done and are doing. After the Franco-Prussian war all France turned in and worked like a beaver to earn and pay the indemnity. France became highly prosperous. Germany, receiving the indemnity, became slothful and extravagant. The condition was so marked that a German comic paper a few years after the war exclaimed: "Let us have another war; let us be beaten and pay an indemnity and then we shall be prosperous again."

Many a true word is spoken in jest. Is that utterance of nearly a half century ago to prove prophetic? It is not as to France, for France is working, hard and intelligently. The French realize how much they lost, even though they won the war. Probably they would not be spoiled in any event, but they are not receiving the indemnity fast enough to put them in any danger. We need to take a lesson from France, for we are not as much better off as we think.

Now as to Germany, our latest advice from our Berlin correspondent tells of the progress the Stinnes movement is making in the German coal industry. In the Essen field an understanding has been reached on the Stinnes basis and the idea is spreading. The basis is far removed from Marxian socialism, which it is downing so far at least as concerns the coal industry. Our correspondent says of it: "Socialization, as is now proclaimed, can be nothing else than a process for obtaining the most complete and economical utilization of all industrial products in the interest of the whole nation, whereby all classes taking part in the production should have a share in the control and in the responsibility." No change from existing conditions is to be tolerated except it promises improvement along this line. Ownership in the mines is unchanged, but workers are given opportunity to buy stock. Trusts as hitherto known are abolished. Production is to be increased, the existing mines being worked more intensively, instead of new shafts being sunk, strong and weak mines being joined to provide capital for improvement.

The operators and miners are to join hands, on the principle of "the interest of the whole nation." In the United States we have seen grounds for suspecting the operators and miners agreeing with each other too readily, with shortage of coal and high prices coming next, and the "percentage of operation" of the mines computed by dividing the number of hours in a day worked by eight, which is one-third of the twenty-four hours during which the capital involved is expected to draw interest and profits. Recently there have been some disclosures as to the building industry in New York where a curious mutuality of interest was shown to exist between labor unions and their employers.

We delude ourselves into thinking that we can afford to do these things, to be unintelligent and lazy and to exploit one another, that only the countries that are in a bad way need to work hard and efficiently. But we did lose by the war and we had better recognize the fact. Sir GEORGE PAISH "said something."

British Progress In Chemistry

REAL discourses for the guidance of the chemist are far from plentiful. Elsewhere in this issue will be found Mr. MACNAB'S thoughtful introduction to the Ministry of Munitions' publication "Preliminary Studies for H. M. Factory, Gretna," which is a true sermon for chemists and chemical engineers everywhere. If men of the profession are to assume the higher positions in industry they must secure experience in common-sense methods of procedure for construction and operation of plants, in things mechanical as well as chemical, in finance and organization. With such training, plus scientific education, they cannot fail to become the keymen in many industries now unaware of the benefits of technical control of operations.

Review of the book noted above will also be found in this issue. The methods of studying problems of plant design introduced by Mr. QUINAN as shown in the text have been the subject of favorable comment from several sources and hold the lesson of simplicity and clearness for technical procedure. QUINAN was a tower of strength to the British Ministry of Munitions. Not only was he forceful and vigorous in combating official ignorance and apathy, so that his plans and proposals were accepted, but he was unusually successful as a teacher in training the members of his technical staff. His final reports are models of excellence in portraying graphically the technical operations at various munition factories. Since Mr. QUINAN was a native American, we too may take some pride in his achievements for one of the Allies.

Arsine Poisoning

A BRIEF statement in Mr. HANLEY'S contribution on electrolytic cadmium, published on another page in this issue, warrants especial emphasis. He gives an alternative scheme for treatment whenever arsenic is present in the copper-cadmium-zinc precipitate to be placed in solution, so as to protect workmen from the "violently poisonous gas of reaction," arsine.

Many living chemists and electrometallurgists have had more or less close contact with this specter, and have almost instinctively closed their lungs to its disagreeable smell before inhaling a fatal amount—pure luck, which other men have not had. An amount as little as ½ mg. of the gas has proved fatal to human beings, although more resistant persons have apparently absorbed as much as 8 mg. and yet recovered. Tests at the American University Experiment Station during the war showed that ½-hr. exposure to a concentration of 0.3 mg. arsine per liter of air is fatal to dogs. Mr. HANLEY is therefore correct in calling it a violent poison, a thing always to be safeguarded against.

Any electrolytic process liberating nascent hydrogen in solutions likely to contain arsenic, or on metal anodes containing arsenic, may under certain conditions as to acidity and concentration generate enough arsine to kill all the employees in that department. It is also formed whenever hydrogen is liberated in a solution containing arsenious acid or an arsenite. It will usually be liberated in quantity when acid acts on arsenic-bearing ores, residues or metals. Many electrolytic and solution processes which are potential arsine generators can readily be called to mind; it has been evolved in fatal quantities in tinning sheet iron, and in the solution of argentiferous zinc from Parkes process lead refining; it has killed lead-burners who used hydrogen from impure zinc.

Since the gas is nearly three times as heavy as air, dangerous concentrations may be reached within rooms, or even in the open air, unless all possible generators are covered and the hoods exhausted by fan suction, discharging preferably into a chimney, there to be highly diluted before again reaching the ground. Good ventilation is also necessary, and should be especially insisted upon in winter time, when the tendency of course is to shut the buildings tightly. Portions of a plant under suspicion should also be carefully walled off from adjacent departments, if it is not practicable to house them separately. Finally, the atmosphere from appropriate places should be tested by drawing a continuous stream of bubbles through an indicator like a silver nitrate solution, placed in a conspicuous position so that the darkening caused by traces of arsine will be immediately observed. Or one might devise a continuous Marsh test. Any arsenic mirror would absorb a portion of a beam of light falling upon a selenium cell, which through relays would then operate any electric alarm.

In view of the minute amount which causes death, attention of the responsible engineers should be focused on a careful study of the possibility that arsenic may accidentally or habitually enter an electrolytic or solution process. If it is impossible to eliminate this contingency absolutely, the process should be isolated, and the surroundings well ventilated and constantly tested.

Often the presence of arsine is unknown until its effect on the workmen's health is observed—then, perhaps, only too late! Would it not be well then to inquire among the employees whether they are at times subjected to unexplained attacks of tonsillitis or jaundice?

Symptoms of arsine poisoning are delayed—often as much as twelve or eighteen hours. One effect it takes, often in mild doses, is to cause partial or complete destruction of the mucous membranes in mouth and throat. The sufferer loses the sense of taste, finds it very hard to swallow, and is treated for "malignant tonsillitis." As a rule, however, the first symptoms are nausea, headache and giddiness, followed by jaundice of the skin and inner surface of the eyelids, the latter of which assumes an intense coppery hue. Its essential action is to destroy red blood corpuscles in enormous number, and the liver and kidneys ultimately break down in an effort to eliminate the products of disintegration. The duration of illness, whether fatal or not, is materially longer than that caused by other arsenicals. Eight days would be a minimum period of recovery—more than eight months is often required. Death may come within a day, or wait three or four weeks.

Facilitating Government Service to Industry

INDUSTRY has frequently resented Government efforts to investigate or assist in technical or commercial problems which industrial executives consider "none of the Government's business." Particularly this problem has confronted the technical man in cases where Government investigators working in chemical or engineering fields have striven to study specific industrial processes instead of confining their efforts to a study of fundamental problems common to all branches of one or more industries. Most recently vigorous objection has been raised on the score that the Government was seeking to influence patents, which in the opinion of many are distinctly commercial property.

There are two methods of preventing undue encroachment of public officials on subjects of concern to individual companies. One of these is purely a restrictive obstructionist policy by which the industry attempts to stop work that some Government specialist or executive happens to find interesting or believes to be properly subject to Government study. This policy always results in hostile feeling and very often defeats its own end, by making it appear that the industry has some unwarranted advantage it seeks to preserve.

Why not go to the Government with those problems which it can properly be asked to solve and which industry would like to have it study? Go with assurance that in most cases the Government worker and executive really wants to be of service. If convinced that the work suggested to him is useful and will be appreciated, the worker gladly will follow the desired channel of investigation and the only objection which industry will incur is to convince the legislative and appropriating agencies of the Government (that is, the Congressmen) that financial support should be given to these needed investigations. Once these investigations are properly explained and support of all proper sorts assured, the Government department will no longer show a desire to stray into those other lines which can best be studied by industry itself. Furthermore, the industry will thus obtain that effective Government work which it is entitled to expect from properly supported public agencies.

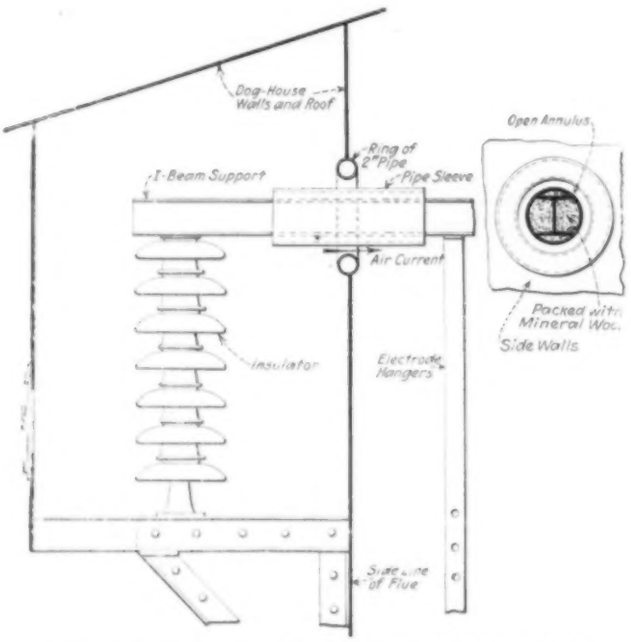
In other words, for the future when we deal with the Government investigations, let's boost what we do want, as well as knock what we don't want.

Western Chemical & Metallurgical Field

Novel Electrical Precipitator

At the Tooele plant of the International Smelting Co. a battery of thirty-two McDougall roasters discharge their smoke into a roomy dust-chamber immediately alongside, connected in turn to the main smelter chimney by a short stretch of brick flue. The dust chamber was designed to support Roesing wires, and these were installed but proved unsuccessful. A great deal of trouble was experienced with loose wires falling into the hoppers due to rapid corrosion near the point of support, the coolest portion. Consequently the wires were removed from the entire chamber.

After work with a small experimental plant, a so-called flue-type treater was installed, and has worked excellently, the recovery of values as indicated by filtration tests exceeding 90 per cent in all cases and at a remarkably low power input. Briefly, the installation consists of a short length of flue in which corrugated iron sheets are hung from the roof and set parallel to the flue-walls, to act as collecting electrodes. Discharge electrodes between plates are formed of gridirons of small iron pipe placed horizontally, and hung from supporting beams at the ends and middle point. Dusty gas thus passes through an electrified zone on its direct



DETAIL WHERE ELECTRODE SUSPENSION PASSES THROUGH SIDE WALLS

route from dust chamber to stack without suffering the usual twistings and turnings of the conventional Cottrell installation.

The flue itself is rectangular in cross-section, with steel top, transite sides, and steel-hopper bottom. Gas velocities approximate 20 ft. per second when twelve McDougall furnaces are operating, yet very high clearances are effected. There is also, curiously enough, a very definite selective action on the mixed smoke—the first hoppers collect material high in copper, while toward the far end the dust runs sufficiently high in lead that its yieldings are sent to the lead blast-furnace plant.

Butterfly dampers, hinged both vertically and horizontally, control the gas distribution at both ends of this short flue; between are four sets of collecting electrodes extending from top of flue to top of hopper, and 10 ft. long. Between sets is left enough open flue to accommodate the discharge-electrode suspension. A particularly clever detail is illustrated in the accompanying sketch, where the electrode suspension passes into a dog-house covering high-tension insulators. A short length of wrought-iron pipe (machined smooth on the outside) is slipped over the I-beam, and this assembly passes the sheet-iron wall through a port-hole framed with a ring of 2-in. pipe. A minimum clearance (equivalent to sphere to plate conditions) prevents large leakage of outside air; any puffs of gas passing outwardly are cleared of dust particles by the charged field existing at the opening. In this manner the insulator is thoroughly protected from dust accumulations, and the treater is protected from a continual inrush of cold air.

Obscure circumstances led to a large overestimate of the electricity needed for operation. Preliminary experimentation indicated that about 50 kva. would be needed, while actually in operation not more than one-quarter of this amount can be put into the treater, this sufficing to catch eight or nine tons of dust daily.

From the description of the installation it may be observed that in effect the treater is really a series of four, each with a gas-travel of 10 ft. Between plate-banks considerable mixing occurs in the current and a solid particle enters the succeeding set at a position random to that at which it emerged. Yet considerable dust is caught on the last plates! Evidently, here is evidence contrary to the idea that a particle in a treater has a path the resultant of a translational velocity and an electrical impulse at right angles. Rather it is that a particle wanders along somewhat aimlessly until fortunately it becomes ionized, and then moves quickly to its oppositely-charged electrode.

Salines in Utah

The assessed valuation of non-metalliferous mining deposits in Utah for 1920 is $22,686,748. The largest amount is for coal lands and totals $19,091,647; sulphur deposits are assessed at $22,530; lime quarries, $31,943; cement rock deposits, $1,372,755; salt and potash deposits, $644,447; alunite deposits, $274,477; asphalt deposits, $1,062,764. These figures are for taxation purposes. In 1917 the assessed valuation of the above lands was $11,012,926.

The potash deposits are in Piute County, and according to the estimate of Prof. William Peterson, geologist for the State Board of Equalization, there is a total of 643,000 tons of material that might be considered valuable for taxation purposes. The phosphate deposits are in Rich County, and consist of patented lode claims totalling 1,375 acres. Mr. Peterson estimates the tonnage assessable at 13,348,000. The gilsonite deposits in

Uintah County aggregate 3,490 acres, with an estimated tonnage of 3,438,500.

The Utah Salduro Co. has been granted a patent to 30,658 acres of land in the Great Salt Lake Desert, title to which was established under placer mining locations, made prior to the date of the leasing law. The company paid a fee of $76,645. This entry covers probably the largest area ever patented under one mineral application. The company extracts potash salts from brine collected by means of dikes, ditches and canals covering a large area. Thus a section of the West heretofore considered so arid and alkaline as to be of absolutely no value is being made to supply a valuable commercial product. The potash industry in this region, however, is in a rather uncertain condition at the present time, owing to the fear of ruinous foreign competition.

A group of Chicago and Indiana capitalists have made application to the State Land Board for the lease of 640 acres of land for the development of potash, alunite and associate minerals. The section of land involved is east of Marysvale, in Piute County.

The Minerals Salt Co. has been recently incorporated with a capitalization of $500,000. The company owns deposits of sodium sulphate on the south shore of the Great Salt Lake.

For some time past, the existence of sodium sulphate around the shores of the Great Salt Lake has been known, and the Midwest Dye & Chemical Co. has been producing glauber salt ($Na_2SO_4.10H_2O$) and salt cake at its plant about two miles southwest of the Garfield smelter. A chemical analysis of the sodium sulphate, made by Walter D. Bonner, head of the department of chemistry at the University of Utah, showed the following results:

	Per Cent
Sulphate, SO_4	63.87
Chloride, Cl	3.64
Magnesium, Mg.	0.24
Calcium, Ca.	0.36
Potassium, K.	0.15
Sodium, Na.	31.37
Total	99.63

Overlying the deposit, the extent of which has not been determined at either the south end or the north end of the lake, is 18 to 24 in. of sand, with some boulders. The overburden is easily removed, exposing the sodium sulphate, which is hard and crusty, and contains about 50 per cent sand. The deposit itself is from 5 to 7 ft. thick. After removing the sand overburden, live steam is injected into the deposit by means of an open-end pipe. The heat causes the salt to go into solution very rapidly, and practically all of the sand settles to the bottom of the deposit. When sufficient solution is accumulated, it is pumped into a small storage tank, where additional settling takes place. This solution is then decanted and stored in shallow evaporating ponds. As the solution cools, crystals of glauber salt form.

To Develop Sodium Sulphate Deposit

A deposit of anhydrous sodium sulphate has been purchased by Western Chemicals, Inc., of Tonopah, Nev., development of the deposit having located considerable quantities of 95 per cent sodium sulphate which can be removed by mining methods and put on the market as dug. The deposit is located about twenty-three miles south of Clarkedale, Ariz., to which place the material is now being hauled by truck.

Preliminary exploration indicates the deposit to be quite large. Not all of the material is of a high degree of purity and it is the intention of the company to build a purification plant of sufficient size to supply any market demand which can be developed.

Canada Copper Corp. Reorganized

The Canada Copper Corporation, Ltd., has again been reorganized—the second time within the last few months. It will be recollected that the old company embarked about two years ago upon a rather ambitious development plan, which it was unable to carry entirely to completion, owing to the unfortunate incidence of high construction costs and low copper prices. Under more normal conditions operation of its 2,000-ton mill at Allenby would have doubtless been successfully under way some time ago.

New Process for the Treatment of Natural Brines

Shortly after the first of the year Wrinkle & Kuhnert, of San Francisco, will begin the operation of a demonstration plant at Keeler, Cal., for the recovery of potassium chloride and borax from Owens Lake's brines. The lake water will be evaporated to the maximum degree of concentration by solar evaporation, and the liquor freed from the mono- and bi-carbonate of soda by treatment with carbon dioxide. Further evaporation in double-effect evaporators will be followed by fractional crystallization. The process differs from others that have been tried in that the borax and potassium chloride are both recovered in a marketable form. The plant has a capacity of about twenty tons of sodium bicarbonate and about ten tons each of borax and potassium chloride.

Bituminous Sand Deposits, Athabasca Region

In the District of Fort McMurray, about 200 miles north of Edmonton, occur vast deposits of bituminous sands, popularly referred to as tar sands. The area of occurrence is vast, that indicated by exposures being estimated from 750 to 1,000 square miles with probably wide extensions under heavy cover. The outcrops along the main river and tributary streams have been estimated as 175 miles in length.

Along these exposures the overburden varies—on some stretches it is reported as too heavy to allow of commercial development, but on others it is comparatively light or easily removable, consisting of shales and sandstones. It is estimated that about 20 per cent of the exposures are of commercial interest owing to the comparative cheapness with which the bituminous sand can be won, and that systematic boring would no doubt disclose many other localities where overburden was sufficiently light to allow of development at reasonable cost.

Analysis of seventy-two samples made in the Department of Mines gives the bituminous content of the sands as from 12 to 17 per cent.

General W. Lindsay claims to have a process for extraction of the crude oil and other values. The results of the General's proposed activities are awaited with interest. The total known deposits have been estimated to hold about 30,000 million barrels of oil.

A sample of the bituminous sands recently displayed in New York at the American Exhibition of Chemical Industries, in the booth of the Canadian Pacific Railway Co., attracted an immense amount of attention. This sample was subsequently treated by two processes and gave a return of over 20 per cent of crude per ton of raw material.—*Agricultural and Industrial Progress in Canada*, Montreal, vol. 2, No. 12, December, 1920, p. 2 7.

Low-Temperature Coking of Utah Coals

A Summarized Description of Laboratory Investigations Made to Determine the Coking Property of a Series of Utah Coals—Analysis of Coals Tested—Apparatus Used—Tabulated Results Obtained

BY OSBORN MONNETT

COKING processes fall into two general classes—high-temperature processes and low-temperature processes. In the first class coal is carbonized at temperature of from 900 to 1,200 deg. C., producing a coke with very low volatile content which is correspondingly difficult to ignite. The low-temperature process, now being given considerable attention by engineers, proposes to carbonize coal at temperatures of 450 to 600 deg. C. and produce a coke with higher volatile content, which can be more readily ignited.

Of the commercial plants in operation in the United States at the present time practically all are high-temperature processes. These include beehive ovens, in which the byproducts are not recovered; byproduct ovens of the Koppers or Semet-Solvay type, and the ordinary gas retorts for the manufacture of illuminating gas. When a ton of coal is carbonized in a byproduct oven at a temperature of 900 to 1,200 deg. C. the following products are obtained: 1,100 to 1,400 lb. of coke; 10,000 to 12,000 cu.ft. of gas (measured at 60 deg. F. and 30 in. pressure); 8 to 12 gal. of tar and 20 to 24 lb. of ammonia as ammonium sulphate.

To supply the present needs of Salt Lake City for domestic fuel only 210,000 tons of coke would have to be produced annually. This would necessitate the carbonization of about 350,000 tons of coal and would produce nearly 4,000,000,000 cu.ft. of gas, 3,500,000 gal. of tar and 4,000 tons of ammonium sulphate.

High-temperature coke usually contains only about 2 per cent of volatile matter and for this reason is difficult to ignite or control in a domestic stove or furnace. However, with proper methods such coke can be made to give good results. Where a supply is available the public should be urged to buy coke and educated in the proper methods of burning it. There are about 15,000 tons of gas coke available yearly in Salt Lake City, most of which is shipped out of the state. A small number of Salt Lake residents have burned this coke for years with satisfactory results. Steps should be taken to bring about the consumption of all this coke in Salt Lake City.

Low-Temperature Coke

During the past ten years increasing attention has been given to the possibilities of low-temperature carbonization. A low-temperature coke is one containing sufficient volatile matter to make a fuel which ignites and burns readily. When coal is carbonized at temperatures of 450 to 600 deg. C., coke and byproducts differing in nature and amount from those produced by the high-temperature process are obtained. The coke still contains from 8 to 15 per cent of volatile matter and is more suitable to domestic use. It ignites readily, somewhat similar to semi-bituminous coal and burns without smoke. The smoke-producing constituents have been decomposed and driven off during the carbonization process.

The tar produced in such a process is a thin fluid better called an oil. It is produced in twice the quantity given in high-temperature carbonization. It contains considerable quantities of motor fuel, burning and lubricating oils, a small amount of pitch and 20 to 40 per cent cresols and other phenols. The gas is produced in smaller amount but is of high calorific value. One ton of coal carbonized at a temperature of about 450 to 600 deg. C. will give 1,300 to 1,500 lb. of coke; 2,000 to 7,000 cu.ft. of gas; 20 to 30 gal. of tar, and 2 to 8 lb. of ammonium sulphate.

Disposal of Byproducts

Disposal of the gas produced offers the most difficult problem in the operation of a high-temperature carbonizing plant at Salt Lake City. Tar and ammonia can be sold at points some distance away. Gas must be consumed as soon as produced and sold in or near the city.

As heretofore shown, a plant of sufficient size to supply a high-temperature coke to domestic consumers in the city would produce nearly 4,000,000,000 cu.ft. of gas. Salt Lake City uses at present about 420,000,000 cu.ft. of gas, or about one-tenth of the amount produced by a plant of the above size. Part of this gas might be used in carbonizing the coal, but disposal of the remainder would be a difficult matter necessitating the selling of the gas at a low rate for industrial and domestic purposes and holding down the production of coke for many years while the demand for gas was being built up.

Low-temperature carbonization produces about one-third as much gas, practically all of which can be used in the carbonization process itself. In this respect low-temperature carbonization seems the more feasible.

Low-Temperature Coking Investigation

In view of the importance of this subject and the fact that little was known of the behavior of Utah coals in low-temperature processes, it was thought advisable to make a rather detailed study of the coking properties of Utah coals and inquire into the state of the art of low-temperature carbonization as represented by various investigators. Results obtained together with an outline of the methods used in the investigation will be set down.

Sunnyside coal is the only known Utah coal of good

EDITOR'S NOTE: This article forms a part of the Bureau of Mines report (June, 1920) on its smoke-abatement investigation in Salt Lake City, as studied in co-operation with that city and with the University of Utah. Published by permission of the Director, Bureau of Mines.

TABLE I. SOURCE OF COALS TESTED

Name of Coal	Salt Lake No.	Pittsburgh No.	Operating Company	Location of Mine
King Lump	34	34103	U. S. Fuel Co.	Mohrland, Utah.
Spring Canyon Lump	35	34033	Spring Canyon Coal Co.	Storrs, Utah.
Clear Creek Lump	36	34034	Utah Fuel Co.	Clear Creek, Utah.
Castle Gate Lump	37	34035	Utah Fuel Co.	Castle Gate, Utah.
Royal Castle Gate Lump	39	34104	Cameron Coal Co.	Castle Gate, Utah.
Peacock Lump	40	34105	Union Pacific Coal Co.	Rock Springs, Wyo.
Peerless Lump	41	34106	Peerless Coal Co.	Spring Canyon, Utah.
Aberdeen Lump	42	34107	Independent Coal & Coke Co.	Kenilworth, Utah.
Wattis Lump	43	34108	Lyon Coal Co.	Wattis, Utah.
Liberty Lump	44	34109	Liberty Coal Co.	Carbon County, Utah.
Hi-Heat Lump	45	34110	Carbon Fuel Co.	Rains, Utah.
Standard Lump	46	34111	Standard Coal Co.	Standardville, Utah.
Pleasant Valley Lump	47	34112	Utah Fuel Co.	Winter Quarters, Utah
Scoffield Lump	48	34113	Union Pacific Coal Co.	Scoffield, Utah.
Wattis Lump (Special sample)	49	34036	Lyon Coal Co.	Wattis, Utah.
Wasatch Coal Co. (Special sample)	50		Wasatch Coal Co.	
Sunnyside	..	33798	Utah Fuel Co.	Sunnyside, Utah.

coking value. A large quantity of this coal is coked in beehive ovens at Sunnyside. This coke is used for metallurgical purposes in Utah and on the Pacific Coast. Sunnyside makes an exceedingly good grade of coke which compares favorably with the best coking coals of the East. Castle Gate coal was at one time used in the beehive ovens, but produces a coke inferior to Sunnyside.

Coals Tested

Fifteen 30-lb. samples of coal were collected from the yards of Salt Lake City. These include practically all the different varieties of coal on the market. Samples of these coals were sent to Pittsburgh for complete analysis. A rapid survey of the coking power of these coals was made, using the 20-g. byproduct apparatus shown in Fig. 1A. Ten of those showing the best performance were shipped to Chicago for testing in the 8-lb. apparatus shown in Fig. 1B.

Description of these coals is set down in Table I. Proximate and ultimate analyses and calorific values appear in Table II.

Description of Apparatus and Methods

Apparatus for Testing 20-g. Sample. This is essentially that described in "Methods of the United States Steel Corporation for the Commercial Sampling and Analysis of Coal, Coke and Byproducts." An electric furnace was used instead of the gas furnace as used by the Steel Corporation. This was found to give a more easily regulated temperature and to be much simpler to operate. The methods of the Steel Corporation call for a progressive distillation process, in which one burner at a time is lighted. This can be accomplished with an electric furnace by surrounding the tube containing the coal with a metal water jacket which is moved backwards at intervals.

Referring to Fig. 1A: An electric furnace (1) sup-

TABLE II. ANALYSES OF COALS

Coal	Lab. No.	Condition	Proximate: Moisture	Volatile Matter	Fixed Carbon	Ash	Ultimate: Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Air Drying Loss	Calorific Values: Calories	B.t.u.
King Lump	34,103	1	4.60	39.57	46.94	8.89	0.47	5.52	70.12	1.37	13.63	2.5	6,968	12,542
		2	....	41.48	49.20	9.32	0.49	5.25	73.50	1.44	10.00	...	7,304	13,147
		3		45.74	54.26		0.54	5.79	81.06	1.59	11.02		8,055	14,499
Spring Canyon	34,033	1	3.88	42.15	46.93	7.04	0.51	5.67	71.99	1.46	13.33	1.5	7,197	12,955
		2	....	43.85	48.83	7.32	0.53	5.45	74.90	1.52	10.28	..	7,488	13,478
		3		47.31	52.69		0.57	5.88	80.82	1.64	11.09		8,080	14,544
Clear Creek	34,034	1	4.24	42.18	47.46	6.12	0.60	5.75	71.96	1.44	14.13	1.3	7,238	13,028
		2	....	44.05	49.56	6.39	0.63	5.51	75.15	1.50	10.82	...	7,559	13,606
		3		47.06	52.94		0.67	5.89	80.28	1.50	11.56	...	8,075	14,535
Castle Gate	34,035	1	3.08	42.26	48.51	6.15	0.32	5.49	72.97	1.27	13.80	0.8	7,288	13,118
		2	....	43.60	50.05	6.35	0.33	5.31	75.29	1.31	11.41	...	7,520	13,536
		3		46.56	53.44		0.35	5.67	80.39	1.40	12.19		8,030	14,454
Royal Castle Gate	34,104	1	3.27	41.18	49.07	6.40	0.47	5.52	73.48	1.39	12.66	1.1	7,277	13,099
		2	....	43.57	50.73	6.70	0.49	5.33	75.96	1.44	10.08	...	7,523	13,541
		3		45.63	54.37		0.53	5.71	81.41	1.54	10.81		8,063	14,513
Peacock Lump	34,105	1	9.66	38.68	48.11	3.55	1.34	5.73	68.37	1.54	19.47	6.1	6,756	12,161
		2	....	42.81	53.26	3.93	1.48	5.16	75.68	1.70	12.05	...	7,478	13,460
		3		44.56	55.44		1.54	5.37	78.68	1.77	12.54		7,784	14,011
Peerless	34,106	1	5.39	40.47	46.86	7.28	0.43	5.57	69.92	1.37	15.43	2.9	6,917	12,451
		2	....	42.78	49.53	7.69	0.45	5.25	73.91	1.45	11.25	...	7,311	13,160
		3		46.34	53.66		0.49	5.69	80.07	1.57	12.18		7,920	14,256
Aberdeen	34,107	1	6.50	42.39	45.14	5.97	0.56	5.78	69.68	1.33	16.68	3.7	6,884	12,391
		2	....	45.34	48.28	6.38	0.60	5.41	74.52	1.42	11.67	...	7,362	13,252
		3		48.43	51.57		0.64	5.78	79.59	1.52	12.47		7,863	14,153
Wattis	34,108	1	6.92	40.77	45.28	7.03	0.86	5.69	68.48	1.35	16.59	4.0	6,801	12,242
		2	....	43.80	48.65	7.55	0.92	5.29	73.57	1.45	11.22	...	7,306	13,151
		3		47.38	52.62		1.00	5.72	79.58	1.57	12.13		7,903	14,225
Liberty	34,109	1	4.42	43.92	45.93	5.73	0.63	5.89	72.23	1.45	14.07	2.1	7,227	13,009
		2	....	45.95	48.06	5.99	0.66	5.65	75.57	1.52	10.61	...	7,561	13,610
		3		48.88	51.12		0.70	6.01	80.38	1.63	11.29		8,043	14,477
Hi-Heat	34,110	1	3.96	44.40	43.95	7.69	0.39	5.52	70.76	1.31	14.33	2.1	6,970	12,546
		2	....	46.23	45.76	8.01	0.41	5.29	73.68	1.36	11.25	..	7,257	13,063
		3		50.26	49.74		0.45	5.75	80.10	1.48	12.22		7,889	14,200
Standard	34,111	1	3.76	45.37	44.89	5.98	0.47	5.80	72.42	1.36	13.97	1.7	7,286	13,115
		2	....	47.14	46.65	6.21	0.49	5.59	75.25	1.41	11.05	...	7,571	13,628
		3		50.26	49.74		0.52	5.96	80.23	1.50	11.79		8,072	14,530
Pleasant Valley	34,112	1	8.86	41.92	44.59	4.63	0.53	5.90	68.90	1.36	18.68	4.5	6,806	12,251
		2	....	45.99	48.93	5.08	0.58	5.40	75.60	1.49	11.85	...	7,468	13,442
		3		48.45	51.55		0.61	5.69	79.64	1.57	12.49		7,868	14,162
Scoffield	34,113	1	2.58	41.40	49.83	6.19	0.54	5.46	74.34	1.39	12.08	0.5	7,326	13,187
		2	....	42.50	51.15	6.35	0.55	5.31	76.31	1.43	10.05	...	7,520	13,536
		3		45.38	54.62		0.59	5.67	81.48	1.53	10.73	...	8,030	14,454
Wattis	34,036	1	7.05	41.43	49.20	2.32	0.81	5.85	72.21	1.47	17.34	3.4	7,191	12,944
		2	....	44.57	52.93	2.50	0.87	5.50	77.68	1.58	11.87	...	7,736	13,925
		3		45.71	54.29		0.89	5.64	79.67	1.62	12.18		7,934	14,281
Sunnyside	33,798	1	4.99	36.27	48.56	10.18	1.43	5.34	69.29	1.52	12.24	3.1	6,934	12,481
		2	....	38.17	51.12	10.71	1.51	5.04	72.93	1.60	8.21	..	7,298	13,136
		3	....	42.75	57.25	....	1.69	5.64	81.67	1.79	9.21	..	8,173	14,711

NOTE: 1—As received. 2—Moisture free. 3—Moisture and ash free.

TABLE III. BYPRODUCT TESTS WITH 20-G. APPARATUS

Coal	Condition	Coke per Cent	Gas Cu.Ft. per Lb.	Tar, Gal. per Ton	Ammonium Sulphate Lb. per Ton	Crude Benzene Gal. per Ton	H_2S per Cent	CO_2 per Cent	H_2O per Cent	Illuminants	CO	H_2	CH_4	C_2H_6	N_2	Calorific Values B.t.u. per Cu.Ft.
										Composition of Gas						
Clear Creek	A	69.1	6.25	20.8	5.3	3.1	0.10	2.15	8.30	5.4	14.7	17.7	49.7	11.0	2.5	929
	B	65.4	3.20	2.5	24.5	3.6	0.08	4.04	8.68	8.8	12.5	36.5	36.5	3.2	2.5	787
Castle Gate	A	70.5	1.34	25.3	5.6	3.4	0.06	2.06	5.88	6.2	11.6	20.8	48.1	12.8	1.5	963
	B	63.6	4.50	9.0	26.8	3.5	0.05	4.05	8.26	10.1	12.6	36.6	37.9	2.9	0.0	831
Royal Castle Gate	A	73.5	0.96	26.7	6.0	3.6	0.16	2.04	7.02	6.6	11.0	16.3	48.5	16.2	1.4	1,020
	B	62.3	4.00	10.9	28.2	3.2	0.02	3.55	9.00	9.4	14.2	39.4	30.5	6.5	0.0	818
Aberdeen	A	75.0	0.97	29.8	6.6	3.1	0.12	2.22	6.84	5.8	16.3	16.6	47.4	13.9	0.0	966
	B	63.0	3.88	3.0	32.0	2.4	0.01	3.80	9.80	9.2	14.2	35.7	37.8	3.1	0.0	815
Liberty	A	74.0	1.48	28.1	6.8	3.2	0.13	2.12	7.52	3.7	13.0	16.9	53.6	12.8	0.0	951
	B	69.5	3.80	3.2	....	3.9	0.04	3.53	4.71	11.7	11.4	33.5	34.4	4.8	4.2	853
Hi-Heat	A	65.0	1.30	42.8	5.0	3.5	0.14	2.13	5.51	9.4	12.5	14.6	40.6	22.9	6.0	1,123
	B	64.5	3.78	3.6	24.4	3.0	0.02	4.00	3.90	9.5	13.9	33.5	35.3	4.5	3.3	813
Standard	A	70.0	1.30	28.9	5.4	3.2	0.09	2.00	6.68	6.0	10.4	18.5	48.3	14.6	2.2	980
	B	57.3	4.65	11.2	23.3	4.5	0.03	3.88	7.59	11.0	12.5	34.2	36.4	3.7	2.2	844
Pleasant Valley	A	67.0	1.30	22.1	9.4	3.3	0.19	2.67	9.73	7.8	15.7	18.5	50.4	7.6	0.0	938
	B	66.0	3.62	0.9	20.4	2.8	0.03	3.70	6.15	10.4	13.3	34.9	33.5	4.0	3.9	810
Wattis	A	63.5	1.40	32.1	7.1	3.0	0.29	2.05	8.94	6.3	14.7	14.7	50.3	14.0	0.0	1,079
	B	63.0	3.66	2.5	27.6	3.8	0.06	3.10	9.90	10.5	13.9	31.6	40.2	3.8	0.0	867
Sunnyside	A	75.0	1.25	23.3	5.3	2.5	0.34	1.14	6.05	5.2	9.4	23.5	50.3	11.6	0.0	942
	B	67.0	3.10	12.5	28.0	2.5	0.04	2.41	7.91	4.8	12.5	35.8	43.1	3.8	0.0	772
½ Sunnyside, ½ Standard	A	71.3	1.19	28.3	4.3	3.3	0.19	1.72	6.05	4.9	8.3	19.0	46.7	13.5	7.6	914

NOTE: A—Carbonized at 540 deg. C. B—Carbonized at 700 deg. C.

plies heat for carbonizing the coal contained in a glass combustion tube. The products of distillation pass through a tar filter packed with absorbent cotton heated by the steam bath (2). The Geissler bulb (3) contains normal sulphuric acid for absorbing the ammonia, a U-tube containing calcium chloride absorbs water, Geissler tube (4) contains strong KOH solution which absorbs H_2S and CO_2, the tubes (5) and (6) contain paraffine oil for absorption of benzene. The gas is measured in the aspirator bottle (7). The furnace was tilted at an angle of 15 deg. to the horizontal to avoid cracking of the tar. Results give the yield of coke, tar, gas, ammonia and crude benzene.

The apparatus was designed to run in comparison with regular coke plant operation until a correlation was obtained. Results are naturally somewhat relative. A maximum temperature of 900 deg. C. is called for in the Steel Corporation methods. The apparatus affords a rapid means of determining in a general way the suitability of coals for byproduct coking.

Tests were made with this apparatus at temperatures of 700 deg. C. and 550 deg. C. It was found impossible to use higher temperatures than 700 deg. C. due to the fusibility of the glass tubes employed. In the tests at 700 deg. C. the progressive distillation method was employed, making use of the sliding water jacket previously described. In the tests at 550 deg. C. the entire tube was gradually heated to the desired temperature.

Results are tabulated in Table III. The low tar yields obtained at 700 deg. C. with some of the coals are not to be taken as indicative of the actual performance of the coal. In the tests at 700 deg. C., the furnace was not tipped at an angle with the horizontal as in later tests and the tar in some cases ran back in the tube and was decomposed.

Apparatus for Carbonizing 8-lb. Samples

This apparatus shown in Fig. 1-B is modeled after the apparatus used by Prof. S. W. Parr of the University of Illinois.[1]

[1]Use of the apparatus was obtained through the courtesy of the Commercial Testing & Engineering Co., 1785 Old Colony Bldg., Chicago, Ill. Our thanks are due to W. D. Langtry, president of the company, for making possible use of the apparatus and to J. F. Kohout, chemical engineer, for valuable assistance and advice in making the tests.

TABLE IV. RESULTS OF LOW-TEMPERATURE CARBONIZATION

Tests run on 8 lb. of coal. Maximum temperature 1,000 deg. F.

Coal	Condition	Coke Lb. per Ton	Coke Per Cent	Gas At 60°F. and 30 In. Pressure, Cu.Ft. per Ton	Gas Cu.Ft. per Lb.	Tar Lb. per Ton	Tar Gal. per Ton	Ammonium Sulphate, Lb. per Ton	Composition of Gas CO_2	Illuminants	H_2	CO	CH_4	C_2H_6	N_2	Calculated Calorific Value B.t.u. per Cu.Ft.
King	1	1,464	73.2	2,580	1.29	155	19.0	10.0	8.1	6.9	26.0	7.2	36.1	8.6	7.1	784
	3	1,425	71.3	2,980	1.49	179	22.0	11.6	....	....	....	....	....	....	....	....
Spring Canyon	1	1,464	73.2	4,100	2.05	129	16.1	....	6.0	4.9	34.4	9.9	42.0	2.8	0.0	732
	3															
Castle Gate	1	1,416	70.8	3,040	1.52	214	25.5	10.4	8.0	7.0	27.0	7.7	41.0	7.0	2.3	813
	3	1,397	69.8	3,350	1.68	236	28.1	11.6	....	....	....	....	....	....	....	....
Royal Castle Gate	1	1,376	68.8	2,780	1.39	213	26.4	8.0	8.1	7.1	26.6	5.5	41.0	8.7	3.0	838
	3	1,331	66.6	3,040	1.52	233	29.0	8.8	....	....	....	....	....	....	....	....
Aberdeen	1	1,290	64.5	3,860	1.93	174	21.2	10.4	7.9	5.5	30.0	8.6	40.8	4.9	2.3	753
	3	1,292	64.6	4,300	2.15	199	24.2	12.0	....	....	....	....	....	....	....	....
Liberty	1	1,406	70.3	2,340	1.17	194	24.0	7.2	4.6	8.7	24.0	7.6	49.8	5.3	0.0	904
	3	1,390	69.5	2,620	1.31	216	26.8	8.0	....	....	....	....	....	....	....	....
Standard	1	1,384	69.2	2,840	1.42	182	22.5	7.2	6.2	7.1	24.8	7.9	45.0	9.0	0.0	887
	3	1,310	65.5	3,140	1.57	202	24.9	8.0	....	....	....	....	....	....	....	....
Scoffield	1	1,392	69.6	2,540	1.27	180	22.4	8.4	8.1	8.3	25.0	7.3	38.9	9.9	2.5	868
	3	1,365	68.3	2,780	1.39	197	24.6	9.2	....	....	....	....	....	....	....	....
Wattis	1	1,262	63.1	3,900	1.95	152	18.2	11.2	5.6	4.9	34.6	8.3	32.8	5.6	8.2	685
	3	1,282	64.1	4,320	2.16	168	20.1	12.4	....	....	....	....	....	....	....	....
Wasatch Special	1	1,250	62.5	4,940	2.47	192	23.9	8.8	6.8	4.9	33.5	8.2	34.4	9.1	3.1	757
	3	1,230	61.5	5,550	2.79	216	26.8	10.0	....	....	....	....	....	....	....	....
Sunnyside	1	1,360	68.0	3,240	1.62	189	23.0	10.0	5.0	7.1	27.8	6.4	43.7	7.9	2.1	858
	3	1,365	68.3	3,650	1.83	212	25.6	11.2	....	....	....	....	....	....	....	....
½ Sunnyside, ½ Standard	1	1,328	66.4	3,860	1.93	217	26.3	12.4	6.3	8.1	30.5	6.4	39.7	6.4	2.6	824
	3	1,335	66.8	4,300	2.15	242	29.4	14.0	....	....	....	....	....	....	....	....

NOTE: 1—As received. 3—Moisture and ash free.

TABLE V. ANALYSES OF COKES

Coal	Lab. No.	Condition	Proximate: Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Air Drying Loss	Calorific Values: Calor's	B.t.u.
King.....	34,348	1	1.00	19.84	64.35	14.81	0.53	Gain	6,793	12,227
		2	....	20.04	65.00	14.96	0.54	0.1	6,862	12,352
		3	....	23.57	76.43	.....	0.63	...	8,069	14,524
Castle Gate.....	34,349	1	1.22	16.51	72.09	10.18	0.40	0.2	7,093	12,767
		2	....	16.71	72.98	10.31	0.40	...	7,181	12,926
		3	....	18.63	81.37	.....	0.45	...	8,007	4,413
Royal Castle Gate.....	34,350	1	1.28	16.26	72.08	10.38	0.49	0.2	7,112	12,802
		2	....	16.47	73.02	10.51	0.50	...	7,204	12,967
		3	....	18.40	81.60	.....	0.56	...	8,050	14,490
Aberdeen..	34,351	1	0.86	14.87	72.85	11.42	0.56	Gain	7,081	12,746
		2	....	15.00	73.48	11.52	0.56	0.3	7,143	12,857
		3	....	16.95	83.05	.....	0.63	...	8,073	14,531
Liberty...	34,352	1	1.60	19.24	69.69	9.47	0.64	0.5	7,226	13,007
		2	....	19.55	70.83	9.62	0.65	...	7,344	13,219
		3	....	21.63	78.37	.....	0.72	...	8,125	14,625
Standard..	34,353	1	1.48	16.84	68.55	13.13	0.56	0.5	6,913	12,443
		2	....	17.09	69.58	13.33	0.57	...	7,017	12,631
		3	....	19.72	80.28	.....	0.66	...	8,096	14,573
Scoffield...	34,354	1	1.18	16.39	73.06	9.37	0.52	0.1	7,240	13,032
		2	....	16.59	73.93	9.48	0.53	...	7,326	13,187
		3	....	18.33	81.67	.....	0.59	...	8,093	14,567
Wattis....	34,355	1	1.93	10.46	81.67	5.94	0.73	0.6	7,509	13,516
		2	....	10.67	83.27	6.06	0.74	...	7,657	13,783
		3	....	11.36	88.64	.....	0.79	...	8,151	14,672
Wasatch Coal Co.. Special	34,356	1	1.22	13.38	73.88	11.52	0.50	0.0	7,130	12,834
		2	....	13.55	74.79	11.66	0.51	...	7,218	12,992
		3	....	15.34	84.66	.....	0.58	...	8,171	14,708
Sunnyside.	34,357	1	1.39	12.32	76.85	9.44	1.09	0.5	7,272	13,090
		2	....	12.49	77.94	9.57	1.11	...	7,375	13,275
		3	....	13.81	86.19	.....	1.23	...	8,155	14,679
½ Sunnyside ½ Standard	34,358	1	1.44	11.35	78.54	8.67	0.70	0.3	7,342	13,218
		2	....	11.52	79.68	8.80	0.71	...	7,449	13,402
		3	....	12.63	87.37	.....	0.78	...	8,168	14,706

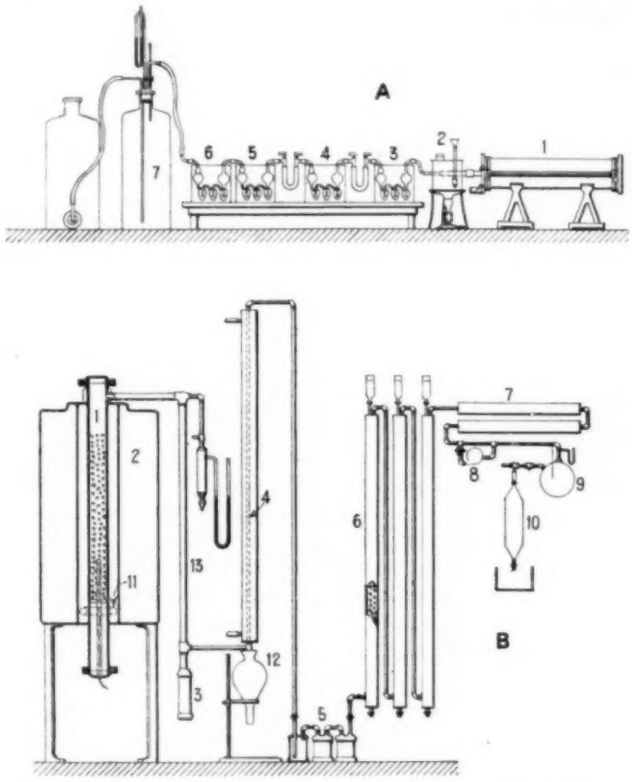


FIG. 1. DIAGRAMS OF EQUIPMENT FOR BYPRODUCT COKING TEST

A. Apparatus for carbonizing 20-g. samples. B. Apparatus for carbonizing 8-lb. sample.

The coal is carbonized in a vertical retort of 3½-in. pipe (1). This is surrounded by firebrick jacket (2) and heated by ring burner (11). The flame of the burner is so regulated that it surrounds the pipe from bottom to top. Tar condensed in the air condenser (13) is caught in the trap (3). Condensate from the water condenser (4) is caught in the separatory funnel (12). The gas then passes through the scrubbers (5) and (6), through the H_2S purifier (7) and is measured in the meter (9). Samples of gas are taken for analysis by means of the sampling tube (10). The rotary pump (8) serves to regulate the pressure, which is measured by a manometer.

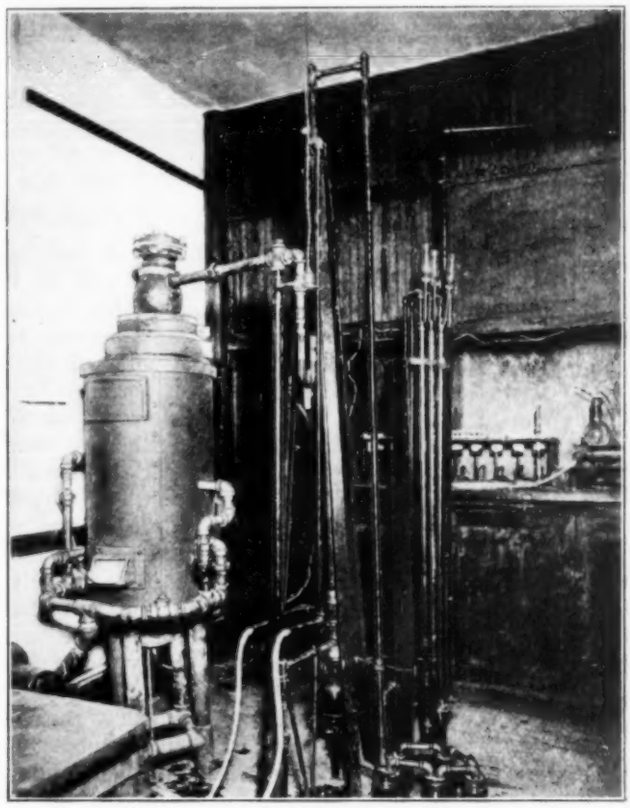


FIG. 2. COKING APPARATUS, 8-LB. SAMPLE, SET UP IN THE LABORATORY

In the tests on Utah coals, the maximum temperature of carbonization was 1,000 deg. F. This temperature was reached in about two hours and maintained for two hours longer. Tar and gas evolution was as a rule practically complete after the first two hours.

Results are tabulated in Table IV. Analyses of the coke are given in Table V. The sample of Sunnyside coal used in coking tests was a different sample from the one analyzed. In figuring the moisture and ash free values for the byproduct yields on this coal an approximation was used.

Character of Coke Produced

Results show that while a number of the coals have a marked tendency to coke, Sunnyside is the only coal which can be called a good coking coal. Castle Gate makes a fair grade of coke. A mixture of one-half standard and one-half Sunnyside made a good coke.

A number of investigators are working on modified methods of coking and claim to have made satisfactory coke from coals not known as strictly coking coals. More research work is necessary before it can be established definitely how far such processes will go in making satisfactory coke from non-coking coals. In the meantime the matter must be considered as in the experimental stages and as something to be worked out in the future.

Legal Notes

By Wellington Gustin

Where Trade Custom Becomes Part of Contract

The Colfax Gin Co., of Colfax, Ga., sued for the purchase price of a carload of cotton seed sold by it to the Buckeye Cotton Oil Co., contending that it was entitled to recover for the amount of seed as shown by the weights when loaded at Colfax, the point of shipment. It was provided by the contract of purchase that the defendant was to pay for the cotton seed a stated price per ton "f.o.b. Colfax, Ga." The Buckeye company contended that it should pay only for the amount of seed received at the point of destination, and alleged that "in the cottonseed oil business it is a custom to settle and pay for all shipments of cotton seed at mill weights—that is, the weight at time and place of delivery—and said custom is of such universal practice that it becomes a part of all contracts for shipment and purchase in carload lots of cotton seed, and was a part of the contract in this case."

The trial court allowed the Buckeye company thus to amend it answer. But the Colfax company objected, contending that "the contract sued on was not ambiguous and that the Buckeye company could not set up and prove in defense of the suit the alleged custom which sought to vary the terms of the contract," and that "f.o.b. Colfax," as contained in the contract, meant that title to the seed passed to the buyer as soon as loaded and that any loss in weights would fall on the purchaser.

On this controversy the Court of Appeals of Georgia held that while a custom or usage of trade cannot be set up to vary a written unambiguous contract whose terms are incompatible therewith, the words and letters "f.o.b. Colfax," as contained in the contract of purchase, would ordinarily mean merely "free on board" at that point, and that the purchaser was to be responsible for the cost of shipment, and the contract as made was therefore silent as to what weights were to govern in the settlement for the cotton seed. Therefore the amendment allowed the Buckeye company was proper. (75 Am. S.R., 73.) And while, in the absence of an agreement to the contrary, delivery of freight to a common carrier is regarded as delivery to the consignee and any loss or damage to the goods while in transit would fall on the purchaser, this rule may be varied by agreement (80 S.E., 863); and if at the time the contract of purchase in the instant case was made there existed such a custom as that alleged by the Buckeye company which was of such universal practice that it became by implication a part of the contract, this would amount to such an agreement as would prevent the application of the general rule above stated.

The defendant debtor herein sent a check to plaintiff creditor for the amount which the debtor claimed was due. The creditor held this check and the debtor contended this was accord and satisfaction. On the point the court said that in the absence of an agreement to the contrary, a bank check thus tendered as in full payment is not such until it is itself paid, under the Georgia statute. Thus, where a claim is unliquidated because of a bona fide dispute as to the amount due, and the debtor sends a check to the creditor for the amount which the debtor claims is due, but for less than the amount claimed by the creditor, with and upon the express condition written upon the check that it is to be in full settlement of the disputed claim, it is only where the creditor either has agreed to accept or after the tender actually does accept such a check as being of itself in full settlement of the unliquidated demand that the mere retention of such an unpaid check can be set up as an accord and satisfaction.

The evidence in this case being in conflict as to whether or not there had been an express agreement that the check itself was to be accepted as payment, the trial court erred in directing a verdict for the Colfax company and the judgment was therefore reversed.

When Broker Earns His Commission

The United States Circuit Court of Appeals, Second Circuit, reversed the District Court for the Southern District of New York in the action brought by Francis H. Baldwin against Jardine, Matheson & Co., in which judgment was given the defendant. Baldwin sued to recover commissions in procuring a purchaser for 10,000 base boxes of tin plate. His commission was to be the sum obtained in excess of $8.50 per base box. After hearing the evidence the court directed a verdict for defendant, and plaintiff appealed. The question argued on appeal was whether a jury question was presented which required its submission to the jury.

The plaintiff alleged that he secured a buyer, the American Trading Co., for the 10,000 base boxes of tin plate at a price of $9.25 per base box; that Jardine, Matheson & Co., Ltd., agreed to and accepted the terms of the sale, payment to be made upon receipt of the tin plate at the dock of the American Trading Co. at Yokohama, Japan. It was further alleged that, in violation of the agreement made with the American Trading Co., the defendant refused to make delivery of the boxes of tin plate, or to pay the commission.

On the question presented on appeal the court said that in an action by a broker for commission on a sale of merchandise, whether the agent who made the purchase had authority, or whether, if not, his action was ratified by his principal, are both questions for determination by the jury.

The plaintiff was entitled to succeed, irrespective of whether the defendant acted in good or bad faith in endeavoring to deprive him of his commission. There is no difference between failure to perform because of bad faith or inability. It is sufficient to entitle a broker to his compensation if it appears from the evidence that a sale was effected through his agency in procuring a buyer. If his communications with the purchaser have been the means of bringing the purchaser and principal together and the sale is agreed upon in consequence thereof, his right to compensation is perfect. The broker is not entitled to compensation for unsuccessful efforts to make a sale unless the failure has been caused by the fault of his principal. When he has been allowed a reasonable time to effect a sale, and has failed, and the principal has in good faith terminated the agency and effected the sale through his own efforts, the latter is not liable for commissions.

Again it was said that a court may direct a verdict only where the evidence is undisputed and so plainly preponderant on one side that it practically becomes conclusive, so that reasonable minds could not differ as to the conclusions to be drawn from the testimony.

Adsorption by Silica Gel*—III

Physical Properties Affecting Plant Design for Solvent Recovery, Drying Air and Industrial Vapor Recovery — Vertical Cylindrical and Bed Type Absorbers — Typical Plant Testing Records†

BY E. B. MILLER

SILICA gel is prepared under carefully standardized conditions and when dried and activated has a moisture content of 5 to 7 per cent. It is a semi-transparent, glassy, brittle, highly porous substance. Its hardness is from 4.5 to 5.5 on the mineral scale and it suffers but slight abrasion with ordinary handling. If, when activated, it comes in contact with water or other liquid rapid adsorption takes place with evolution of heat and the granules are shattered.

The pores are ultramicroscopic and neither the structure nor adsorptive properties are measurably altered by pulverizing the gel to pass 200 mesh or heating

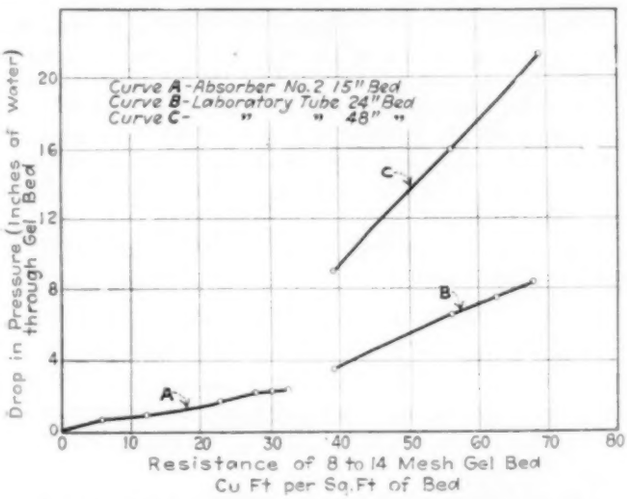


FIG. 13. RESISTANCE TO VAPOR AND GAS PASSAGE

gradually to 650 deg. C. Its internal volume is indicated by the fact that 1 g. of gel will adsorb 0.41 c.c. of water.

Gel sized from 8 to 14 mesh and containing 7 per cent water weighs 44 lb. per cu.ft.

The resistance of an 8 to 14 mesh gel bed to the passage of air or vapor through it is an important practical factor. Laboratory and plant results are given in Fig. 13. Plant absorbers have staggered heating flues in the bed which modify the laboratory test conditions.

During adsorption the heat of condensation is liberated and, despite radiation losses, a rise of as much as 25 deg. C. in gel temperature has been noted when there was no attempt to cool the gel by ventilation or water jacketing during the adsorption cycle.

Gel can be used either in the granular or pulverized form and the work with semi-commercial scale bed type absorbers for granular gel and that now under way with pulverized gel will now be described.

The first plant absorber is shown in Fig. 14. It is a vertical cylinder with vertical heating and cooling tubes 1 in. in diameter on 2-in. centers passing through the gel bed, which is 26 in. deep supported on a screen about the middle of the cylinder. Hot gases or cooling air or water may be passed vertically through the tubes and the gas for adsorption enters and leaves by side outlets below and above the gel bed, which contains 250 lb. of 8 to 14 mesh gel. Most of the practical work on SO_2 adsorption and recovery was done with this absorber.

The first absorber did not have welded tubes, and to overcome difficulties in keeping it tight and getting even distribution of the heat the second absorber was built.

Figs. 15 to 17 show the second bed type absorber plant. The absorber *A* is a rectangular steel box 3 ft. 9 in. x 3 ft. 6 in. x 2 ft. 10 in. high with a 420-lb. gel bed 9.75 sq.ft. x 13 in. deep, supported on a perforated metal screen. Through the gel bed passes a series of horizontal 1-in. tubes on 2-in. centers. These tubes are welded to the tube sheets, which are inclosed on both sides of the absorber by flue boxes so that combustion gases, air, or cold water can be run through the tubes to heat or cool the gel.

The plant as shown is arranged for drying air. The air enters through an orifice meter *B*, Figs. 15 and 17, passes into the absorber *A* at the lower right corner and up through the cool gel bed, where it is deprived of its moisture, thence by the upper left corner of the absorber through valve 1 to a Roots exhauster *C* and out by valve 2 for use as desired.

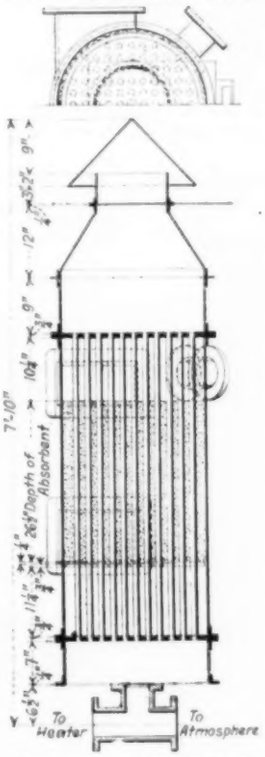


FIG. 14. VERTICAL CYLINDRICAL ABSORBER

If it is desired to continuously make a high extraction of the vapor a second absorber should be connected in series when the effluent from absorber *A* indicates it is reaching the break-point and absorber *A* is continued in circuit until the gel is saturated. The air is then cut off at damper 1 and the gel is dried or reactivated by heating and sweeping hot air through it. The heating or evacuating cycle is shown in Fig. 15. Combustion gas or hot blast is admitted alternately by the dampers 2 and 3, passing through the tubes in the gel and out by dampers 5 and 6 to the heat exchanger *D*. Air is admitted to the heat exchanger on the lower right side, is heated and passes through valve 5 to the bottom inlet of the absorber, thence through the gel to the blower

*Paper presented before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

†For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 24 and 25, Dec. 15 and 22, 1920, pp. 1,155 and 1,219.

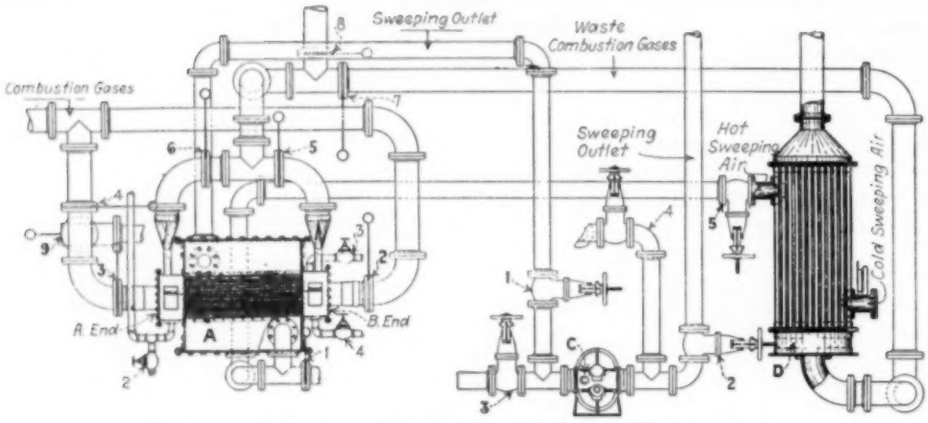


FIG. 15. BED TYPE ABSORBER AND CONDENSER PLANT

and to waste through the valve 2, carrying with it the released moisture.

When the gel is dried cooling may be hastened, if necessary, to prepare it for the next absorption cycle by blowing cold air from inlet valve 3 through valve 4 and dampers 9 and 3 through the absorber tubes and out by damper 5. Water spray is used with this cooling

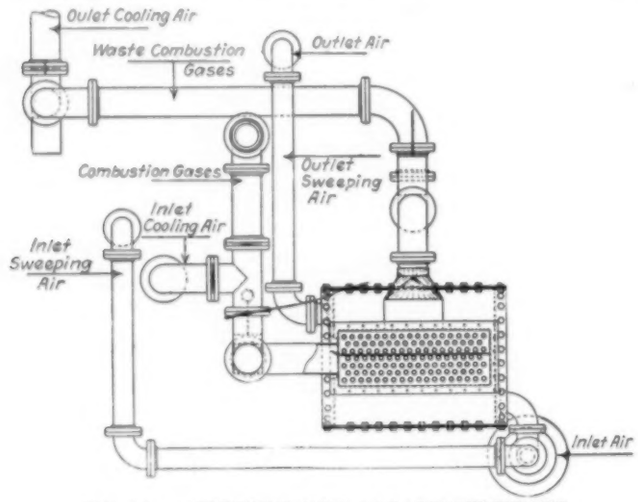


FIG. 16. ABSORBER BOX AND CONNECTIONS

air at the start and the tubes and flue boxes are flooded with water when the temperature is below the boiling point. The next cycle can be started when the temperature has been reduced to 75 deg. C., as the air being dried will assist in the cooling and the jacketing water will lower the gel to a moderate temperature before the break-point is reached.

The air drying tests were made in this absorber.

A third type of bed absorber using granular or unsized gel flowing slowly through a louvered or screened compartment, thus making a continuous absorber, is under consideration.

For continuous operation and uniform product three fixed bed type absorbers are needed so that a second one can be put in circuit a safe interval before the first one reaches its break-point while the third one is on its heating and cooling cycle.

In the pulverized gel absorber the activated dust is fed into the gas stream discharging into a dust filter, adsorption taking place in the duct and filter bags.

This method is attractive from several points of view.

It requires only standard equipment such as is regularly used in feeding powdered coal and in dust separating in metallurgical plants.

It seems clear that a smaller quantity of gel would be required for a given duty than with a bed type absorber, because there is no time lost in heating and cooling an absorber nor is there any idle gel in an absorber bed.

The heat is economically applied since the heater is always hot, as against the intermittent heating and cooling of the bed absorber.

Preliminary tests in the laboratory using 80 and 200 mesh gel in a current of air with 2 to 6 grains of moisture per cu.ft. reduced the effluent in one stage to from 1.0 to 1.3 grains. In the above tests the time of contact between air and gel did not exceed four seconds, which later experiments have shown to be inadequate. Apparatus now under construction will permit longer and better contact.

Fig. 18 is a suggested flow diagram for a pulverized gel absorption plant.

Experimental Plant Results

A large number of tests were made with the No. 1 absorber on the adsorption and recovery of sulphur dioxide from air mixtures ranging in concentration from 2.5 to 8.75 per cent by volume. The data are too bulky to include in this paper.

Fig. 19 gives the results of a typical run on adsorption from an 8.75 per cent mixture. The mean temperature of the gel at the end of the run was about 40 deg. C. and it adsorbed 17 lb. of sulphur dioxide, or 6.8 per cent of its own weight.

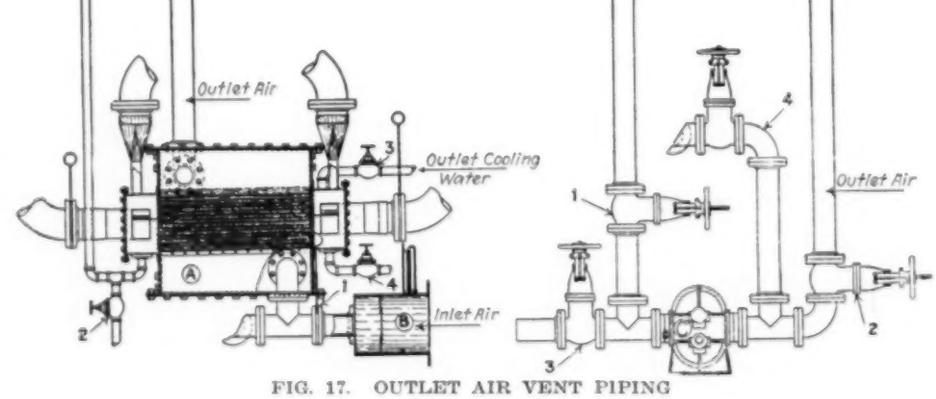


FIG. 17. OUTLET AIR VENT PIPING

Referring to the curves already given it will be seen that this corresponds approximately to the saturation value.

A number of tests on the recovery of adsorbed sulphur dioxide were made using absorber 1.

Starting with an 8 per cent mixture of sulphur dioxide and air, the gel adsorbed 5 to 6 per cent of its weight of sulphur dioxide. The absorber was then heated to about 125 deg. C. and the vapor pumped off.

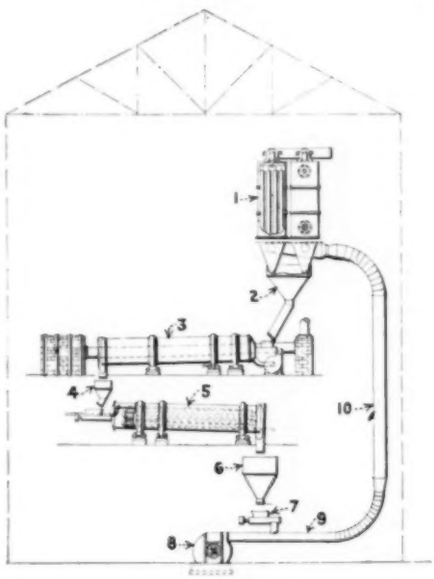


FIG. 18. FLOW DIAGRAM PULVERIZED GEL PLANT

Most of it came off at a 25-in. vacuum. The liberated vapor was liquefied at 25 deg. C. by compression. The details of these experiments it is not necessary to give here.

In other tests the gas was delivered by the vacuum pump directly to a dry gas meter. At frequent intervals analyses of the gas were made and the volume noted.

Fig. 20 shows the results of a typical run made in this way. It will be observed that the absorber was partially evacuated for a few seconds before heat was applied and the gas wasted for this brief interval, in order to eliminate as much of the air in the apparatus as possible without waste of sulphur dioxide. The first analysis, made at the end of four minutes, when the temperature of the gel was about 65 deg. C., showed 85 per cent sulphur dioxide.

In plotting the curve which expresses the vapor

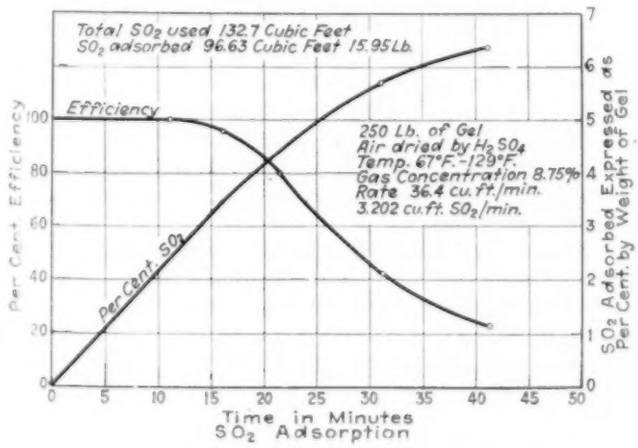


FIG. 19. PLANT RECORD ON SO_2 ADSORPTION

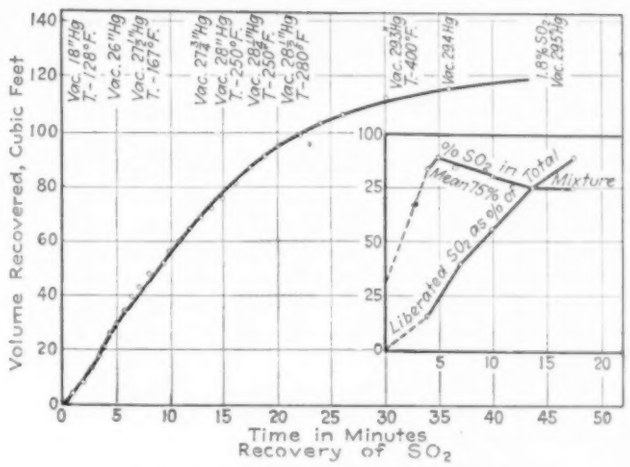


FIG. 20. TYPICAL PLANT RECORD

liberated as percentage of the total quantity adsorbed it was assumed that the average composition of the vapor during the first four minutes was 57 per cent.

Making this assumption, we see that during the first eighteen minutes about 90 per cent of the total vapor was liberated at a mean concentration of 75 per cent. The 25 per cent air resulted partly from the air originally present in the absorber and connecting pipes, but mainly it resulted from leaks in absorber, valves and pump.

AIR DRYING

Fig. 21 is a composite of the results obtained in eight runs with the second absorber with an air current through the absorber of 330 cu.ft. per minute, or at

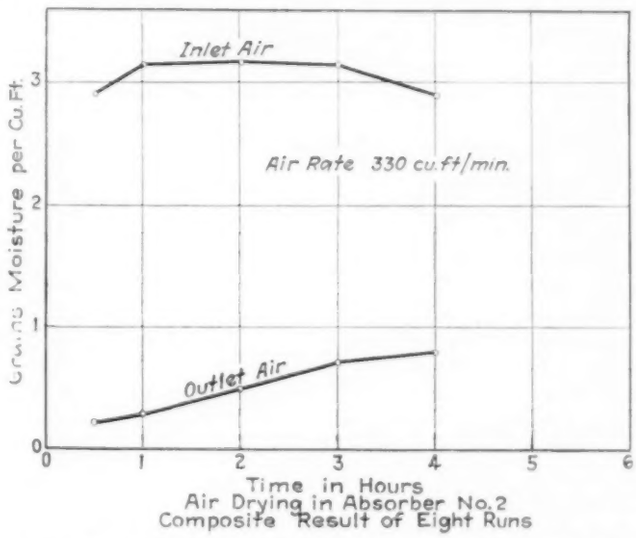


FIG. 21. COMPOSITE OF EIGHT RUNS ON DRYING AIR

the rate of 33.8 cu.ft. per sq.ft. of gel bed, or 0.78 cu.ft. per lb. of gel. These runs were made in March, so that unfortunately the atmospheric humidity in none of these tests exceeded 5.3 grains per cu.ft. Few of our large-scale tests as yet show the sharp break-point obtained in the laboratory work, but it will be noted that if we assume the allowable end point to be when the dried air rose in water content to 0.7 grain per cu.ft. the gel was in service an average of three hours, or that one 420 lb. absorber dried over 59,000 cu.ft. of gas before the water content of the outgoing air rose to 0.7 grain.

The 0.7 grain end point is assumed because it is

below the moisture content in any continuous run of a Gayley dry blast plant of which we have record.

Fig. 22 is of a run at 225 cu.ft. per minute rate when the humidity averaged about 4.5 grains per cu.ft. and the outlet air reached the 0.7 grain end point in four hours, forty-five minutes, finally rising above this point

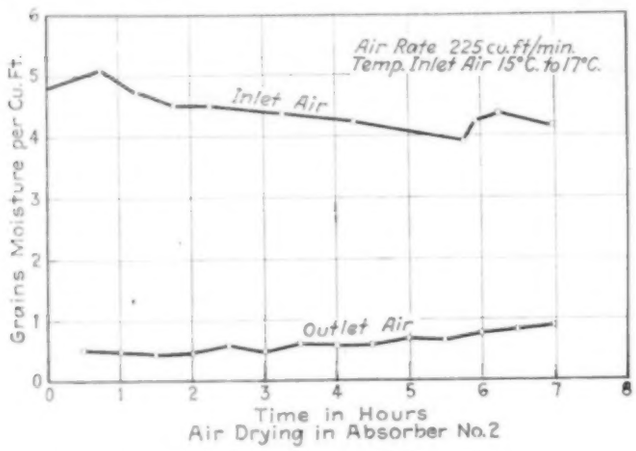


FIG. 22. DRYING AIR AT A RATE OF 225 CU.FT.

in five and one-half hours. When atmospheric humidity was below 2 grains runs of six and seven hours have been made without reaching the 0.7 grain end point.

Industrial Applications

It will have been seen from the preceding discussion that silica gel is adapted to recovering the vapors of all liquids.

This property may be applied to the following among many other practical commercial problems:

Drying air: Air conditioning; dry-air blast for furnaces.

Gasoline recovery: From gas wells; casinghead gases; losses from storage tanks; losses in oil refineries.

Solvent recovery: All industries using volatile solvents.

Recovering industrial vapors: Notably sulphur dioxide and oxides of nitrogen.

Selective separation of mixed gases.

A more specific list of possible applications is not within the limits of the present paper.

While further work remains to be done to reduce the above applications to commercial practice, we feel that the theoretical and scientific aspects of the problem have been completely solved, and that to make commercial application requires only the perfection of mechanical equipment, which presents no serious engineering difficulties.

The progress already made in this direction, as indicated by the results of the experiments here recorded and other experimental operations now under way, conclusively establish the practicability of silica gel as a means of recovering the various vapors mentioned above.

Acknowledgments

The work necessary for the preparation of this paper was divided into three general groups, and intrusted to members of our research and engineering staffs as follows:

Theory, to Walter A. Patrick; laboratory results, to Benjamin F. Lovelace; experimental plant, to Edwin C. Holden.

British Progress in Chemistry*

By William Macnab

THE war has shown up very clearly many of the weaknesses in our technical educational system. On the other hand, it has brought many professors into close association with technical men and processes, and this no doubt has produced a greater appreciation on their part of the necessity of providing more technical instruction for students who purpose to enter chemical industry. Many of the drawings and reports to be issued should prove of much assistance to universities and teaching institutions in carrying out technical instruction, by showing good methods of applying scientific data to industrial questions, and, by presenting concrete examples, thus vitalize to many students the apparently less interesting field of thermochemistry and other branches of physical chemistry.

The resources and ingenuity displayed in meeting the complicated problems arising from the necessity of devising means of protection against gas attacks and the production of gases for attacks show that the country possesses ample chemical ability to meet any calls which may be made.

Closer Co-operation Essential

But to meet the chemical industrial competition closer co-operation between the more strictly theoretical and technical workers is essential, and above all a class of business and financial men must be developed whose education has been sufficiently broad to enable them to realize the sure foundations on which scientific conclusions rest, and to trust their scientific and technical advisers.

In this country there has been too little mutual trust and appreciation of each other, and it must be the serious endeavor of all concerned to develop such sure methods of working out new processes in all details, and clearly presenting the results, that the business man may have a well-defined picture of the advantages to be gained and the cost to be incurred, in so far as the factory is concerned.

Chemical Enterprise Suffers From Ignorance

Chemical enterprise has suffered much from the comparative ignorance of many who entered upon its difficult path. On the one hand, the air of mystery which often surrounds it to the lay mind leads to expectations of almost magical results and exaggerated hopes which are rarely fulfilled.

The business man is often not entirely to blame, for the chemical projects have often been presented to him in a very insufficiently considered manner, so that the attractive points—although no doubt truly put forward—were not sufficiently counterbalanced by a well-reasoned statement of all the sides of the question. Hence disappointment and loss of faith, or, at any rate, considerable skepticism in regard to future chemical projects.

On the other hand, if a non-scientific man has the final decision in regard to a chemical process, his lack of understanding of his technical staff and of faith in their requests, which may go against his so-called common sense, may be as prejudicial as the unreasoning hope before referred to. Unfortunately this trouble

*From the introduction to Ministry of Munitions' publication "Preliminary Studies for H. M. Factory, Gretna, and Study for an Installation of Phosgene Manufacture."

arises from the lack of general scientific knowledge among all classes of society and the failure to appreciate what scientific work stands for, as well as reluctance to make use of the scientific information which is available.

Attitude Toward Chemical Industry Must Be Altered

But if we are to hold our own in the world competition, the attitude to chemical industry must be altered very considerably. Greater knowledge on the part of those directing chemical work and the substitution of the rule-of-thumb men (who are often in complete charge of complicated processes) by intelligent chemists who will make it possible for real progress to be made are among the more obvious reforms to be introduced.

Shrewd common sense and good powers of observation have enabled some of our non-scientific owners or managers of chemical factories to achieve sometimes a considerable amount of success, which has developed in them a corresponding contempt for, and distrust of, scientific control.

It must be admitted that when a young chemist has been taken on in such a works the results frequently have been unsatisfactory, due to lack of knowledge on both sides. Truly Solomon was right when he insisted: "Get wisdom, get understanding." To get it, however, implies hard work and a certain amount of modesty which does not count too much on the influence of heredity.

Problems of Young Chemists in Industry

Our teaching institutions do not turn out industrial chemists ready to step into a works and successfully control processes straight away, nor perhaps is it to be expected or desirable that they should, for after all, works experience and the controlling of men can only be learned in a works. Sometimes the young chemist's position in a works run on rule-of-thumb principles is very trying. His inexperience may lead him into trouble, and his mistakes will cause unholy joy to the rule-of-thumb foreman and anger or dissatisfaction to the uncomprehending employer, with the probable result that he is confined entirely to the laboratory or even dismissed, and scientific control has thus apparently been found to be a fraud.

Or he may develop an unjustified contempt for the "rough and ready" people with whom he has to work, forgetting that the ability to produce something, although unable scientifically to understand and explain the process, is worth more in a works than scientific comprehension of the process along with lack of technical ability to carry it out, or knowledge of pitfalls, should a change be undertaken in the existing practice.

It seems ridiculous to have to plead for the full and proper use of chemists in chemical works, but to those acquainted with the smaller works, and even some of the larger ones, it is known that the necessity exists.

The difficulty would be largely solved if men with good chemical training were in charge of chemical works, for then they could see to the works' training of the young chemists who came under them and prevent them from making rash experiments and, at the same time, utilize to the full extent any knowledge or initiative which they might possess. Above all, such a manager would not be jealous of the chemist.

Repeated opportunities of visiting during the war most of the French factories employed in making explosives and allied chemical products filled one with great admiration for the work accomplished and the developments carried out, and it is evident that a chemical industrial renaissance has taken place in France and manifestly they intend to develop chemical manufacture which the war has shown they can carry on well.

In this country there has also been great chemical development and a new spirit of scientific control and efficiency has been made known widely. Magnificent results have been achieved, but not through rule-of-thumb methods, which one would fain hope were buried forever.

Development on Scientific Lines Urged

It has been abundantly shown that the chemical knowledge and ability in this country, when adequately directed, can hold its own with that of any other land, but the stimulus of the common aim of quantity of output and excellence of production, generated by the war, must not be allowed to die out. Every endeavor should be made by professors and students, technical and business men interested in chemical manufactures, as well as by the government, to get to understand better the aims and requirements of one another, and co-operate in remedying any weaknesses in our system and in developing chemical industry on sound scientific lines.

Progress means change, and the chemical manufacturer should be prepared for having one process ousted by a newer and better way of working, and should reckon with the necessity of scrapping plant from time to time if he is going to keep pace with improvements.

Progressive Spirit Necessary

Sometimes chemical enterprise is deprecated on the ground that no sooner is one method established than a new process threatens to supersede it and therefore there is no certainty of permanence. A truly progressive spirit is necessary and the mental laziness which tends to condemn new ideas because they upset a smoothly running process must be replaced by greater alacrity to undertake new methods with all the attendant trouble, otherwise a back seat will soon be taken by the firm or nation which will not wake up and keep awake. More friendly and intelligent co-operation among masters and staff and ordinary workers will do much to make progress easier. Already there are indications of sounder and humaner ideas coming to the surface, and seeing we have all to spend the greater part of our life working in some capacity or other it is surely worth while endeavoring to make the work as interesting as possible.

Competition Must Be Met

All the chemical manufacturers of the world have been greatly developed and stimulated by the war and competition will be keener than ever on all sides. The old rule-of-thumb practice which prevailed in so many of our chemical factories must go and be replaced through scientific control of every stage of the process.

The necessary data and information are available in the country and there are plenty of chemists with brains who can carry on and develop the good work begun.

The young chemist who starts work in a chemical factory finds himself confronted with plant instead of apparatus, much of which involves mechanical devices

of various kinds, pumps and blow casks for moving liquids, mechanism and compressed air for agitating liquids, various methods of applying heat, etc. He should make it his business to get first-hand knowledge of the way each part of the plant acts and a thorough understanding of the principles on which it works and is constructed.

To do this he should take his coat off when a breakdown or stoppage occurs and see for himself what has been the cause, and learn and help to put matters right. Only in this way can he develop that knowledge of the capacities of a plant and sympathy with it which will enable the best results to be obtained.

A plant should be treated well and considerately, and its legitimate work capacity not overtaxed. Careful attention to its smooth running and maintenance in good condition will be richly repaid in steady and uniform output.

Manual Work by the Chemist Sometimes Necessary and Expedient

There is nothing *infra dig.* in a highly trained scientific man doing the manual work involved in any of the processes under his control. Thereby he acquires a greater sympathy with and understanding of the men who have to do the regular manual work, which enables more just judgments to be formed as to what constitutes a fair day's work, and develops a mutual respect between chemist and workman.

One does not rejoice in dirty work *per se*, but, as a means to an end—viz., the intelligent understanding of plant and process—it should be cheerfully undertaken when occasion arises. Also the more carefully a plant is controlled the fewer interruptions and occasions for rough work will arise.

In the laboratory the chemist is trained to work quantitatively in so far as the main constituent he is preparing or substance he is analyzing is concerned, but he is seldom required to account for the quantity of reagents he employs or the amount of heating or cooling and water for washing he utilizes to effect his end.

Problems of the Plant Chemist

In the factory these questions become of first-rate importance and must be carefully attended to. Every part of the process should be quantitative, and thereby it acquires added interest. The plant should be carefully calibrated, so that accurate measurements and weights of all materials used can be ascertained, and frequent stock taken in order that yields and losses may be accurately known and any departure from the normal at once detected. Let the chemist keep prominently before him in large figures the losses, so that they may be a constant incentive to greater efforts to bring them down to the irreducible minimum.

In order that the chemist in charge of a process may work it to the greatest advantage he must be provided with all available knowledge on the subject, and must be encouraged to investigate by means of laboratory and plant experiments all obscure points and losses. To this end he should be taken as far as possible into the confidence of his employer in regard to costs, so that he may realize the necessity of economy in all directions and be able to measure in one of the terms of industrial success—viz., money—the results of modifications and improvements which he may introduce.

Intelligent and sympathetic co-operation among those in charge of different departments is necessary if the greatest efficiency is to be obtained. Some works have followed the opposite practice and kept the sections in water-tight compartments. Profits have no doubt been made under such systems, but not so great as when the heads and their assistants have opportunity to discuss their several problems together and help one another by trying to work into one another's hands. Without this co-operation the nation loses greatly both in material and the improvements which are sure to flow from the brightening of intellects by free discussion together.

It sometimes happens that owing to exceptional circumstances profits are made alongside of great waste of material. Such a state of affairs is a national misfortune and, apart from the loss of material, which is also likely to be a nuisance to other people, it is demoralizing and engenders a careless, unscientific spirit in those conducting the operations. Preventable waste of any kind should be considered a sin against mankind.

Interest by the Employee an Aid to Better Results

One of the most powerful aids to success would be the intelligent and loyal co-operation between employer and employee with the object of getting the best results from the process being worked. Interest in the work in hand leads to better work being done, and one tendency of the time seems to be a revolt of the individual from being regarded as a "hand" or human machine, and a demand that some of the necessary monotony of the daily task should be brightened by learning as much as possible of the meaning of what is being done and the ideals to be striven for.

The work of a chemist on a plant, although much more varied, can become monotonous too, unless he can see beyond the immediate daily round, and have the interest and stimulus of knowing the profit or loss on his operations, while his attention should be concentrated on the production of the manufactured article at the lowest cost and greatest efficiency.

British Cast Iron Research Association

Good progress is being made with the organization of the British Cast Iron Research Association, which has abandoned the somewhat cumbersome title of the British Gray and Malleable Cast Iron Industries Research Association in favor of the shorter one. Articles of association have been drawn up and approved by the council. Lord Weir of Eastwood has accepted the office of president, H. B. Weekes, F.I.C. (Vickers, Ltd., Barrow), has been appointed chairman of the council, and three additional vice-presidents have been elected.

The basis of subscription of ordinary members has been fixed according to the number of persons employed in the iron founding departments of the businesses. For gray iron foundries the rates are five guineas per annum for less than twenty-five employees, ten guineas for between twenty-five and fifty, and an extra five guineas for every fifty additional employees or fraction thereof. For malleable iron foundries, five guineas per annum for under twenty-five employees, and above that number the rates are those for gray iron foundries increased by 25 per cent. Pattern-makers, clerks, etc., are not to be included in the count of employees. Many of the largest firms in the industries are supporting the association, and ample financial assistance is promised.

Production of Electrolytic Cadmium

A Discussion of the Methods of Producing Cadmium From Impure Zinc Electrolyte, Together With Its Purification From Arsenic, Iron, Copper and Thallium—Cell Room and Melting Practice Is of Extreme Importance, and Is Given in Detail

By H. R. HANLEY*

DEVELOPMENT of the electrolytic process for the production of metallic cadmium described in this article was conducted at the Mammoth Electrolytic Zinc Plant of the United States Smelting, Refining & Mining Co., at Kennett, Cal. The broad development policy adopted by the company, together with generous financial assistance and helpful suggestions received from the technical men in other departments, was essential and contributed largely to the success of the undertaking.

Raw Material

In practically all ores cadmium is present in very minute quantities only. Its production, except as a byproduct where the major portion of the expense of manufacture is borne by some other more commercial metal, is unprofitable. Bag-house condensation products from lead and copper furnaces constitute important sources of raw material from which cadmium may be recovered. Production from this material is, to a certain extent, accomplished electrolytically. Another source of raw material is from zinc ores and blue powder. Cadmium is obtained from these by fractional distillation.

This article describes the production of cadmium by the wet process of extraction, purification of solution and electrolytic deposition, the raw material being a bag-house condensation product from the copper furnaces of the Mammoth plant of the U. S. S., R. & M. Co., Kennett, Cal. The analysis of the raw material is approximately 0.55 per cent Cd, 19 per cent Zn, 6.6 per cent As, with appreciable quantities of Te, Se, Co, Ni, Tl, and of the more commercial metals such as Cu, Au, Ag, Bi and Pb. This raw material is treated for the recovery of zinc by the electrolysis of a sulphate solution. By leaching the raw material with sulphuric acid a solution of the following composition results:

	Zn	Cu	Cd	Fe	Mn	As	Bi	Co	Ni	Tl	Te
Grams per liter	96.0	8.0	5.0	2.0	0.04	0.5	tr.	0.015	0.012	tr.	tr.

In the process for the recovery of zinc the solution is treated with powdered limerock and agitated by air in order to precipitate the iron and traces of arsenic. This treatment also removes about 40 per cent of the Cu, but none of the Cd. A solution results which contains about equal amounts of Cu and Cd. By using zinc dust or other form of zinc, precipitation of the copper and the cadmium is effected in the form of a black mud, which contains approximately 25 per cent Cu, 25 per cent Cd and 30 per cent Zn. This copper-cadmium-zinc precipitate is the raw material from which the cadmium is recovered.

When arsenic is not present in the precipitate, the steps of the process are:

1. Leaching the copper-cadmium-zinc mud with dilute sulphuric acid.
2. Separation of solution from the residual copper mud.
3. Precipitation of cadmium from solution as sponge metal.
4. Solution of the cadmium in acid cadmium-electrolyte.
5. Removal of iron from the solution.
6. Removal of thallium (when necessary).
7. Electrolysis.
8. Melting and boxing for market.

The copper-cadmium-zinc precipitate must be kept moist in order to prevent oxidation of the copper, else this would dissolve during the leaching operation and foul the cadmium solution. The wet precipitate is leached at about 60 deg. C. with dilute sulphuric acid containing 250 g. H_2SO_4 per liter in a paddle agitation tank suitably vented to prevent gases entering the building. When the zinc and cadmium are leached from the precipitate and the acid in the solution is reduced to 10 g. per liter, sufficient powdered limerock is added to consume approximately 80 per cent of the acid. Hydrated lime is then used to neutralize completely the remaining acid. Reasons for this procedure will be explained under the heading "Cadmium and Zinc Separation." The copper residue is separated from the solution by filtration and is eventually sent to the copper plant, where it is recovered as blister. The filtrate is treated for the separation of cadmium and zinc.

Separation of Cadmium From Zinc

The following facts are important in connection with the separation of these metals in a sulphate solution. Powdered limerock will not precipitate cadmium. It will completely precipitate zinc where cadmium is absent. There is no precipitation of zinc by the limerock where cadmium and zinc are present in the solution in approximately equal amounts. Table I will illustrate these facts.

TABLE I. PRECIPITANTS FOR ZINC IN PRESENCE OF CADMIUM

Test No.	Zn Present in Sol.	Cd Present in Sol.	Reagent Added	Temp. of Sol.	Hours Agitation	Effect of Reagent
1	0.95	2.5	Powd. limerock	Room	16	No effect
2	0.95	2.5	Powd. limerock	Room	300	No effect
3	0.95	2.5	Powd. limerock	Room	300	No effect
				80	1	No effect
4	0.95	2.5	$Zn(OH)_2$	80	1	Ppt. of cadmium but not complete
5	0.95	2.5	CaO	80	1	Ppt. of zinc and traces of cadmium
6	0.95	2.5	CaO	80	1	Ppt. of zinc and traces of cadmium
7	0.95	none	Powd. limerock	80	1	Compl. ppt. of zinc

In each of the tests in Table I except the last there

*Formerly superintendent, Kennett Electrolytic Zinc Plant, United States Smelting, Refining & Melting Co.

was used 100 c.c. zinc sulphate solution, containing a total of 0.95 g. zinc and 50 c.c. cadmium sulphate solution containing 2.5 g. cadmium. Powdered limerock and hydrated lime were employed for the precipitation of the zinc, using 10 per cent and 5 per cent in excess, respectively. Zinc hydrate was used for the precipitation of cadmium, with 10 per cent in excess. Considerable care is necessary when precipitating zinc as hydrate from cadmium sulphate solution by means of lime (CaO), and it is doubtful if this could be carried out economically on a large scale. Washing the zinc hydrate precipitate reasonably free from cadmium salts involves the use of excessive wash water, while the unwashed cake will carry from 5 to 8 per cent cadmium.

Precipitation of Cadmium Sponge

In view of the unsatisfactory separation of zinc and cadmium by precipitation of one of these metals by a base, the precipitation of cadmium was finally effected by another method. It was found that cadmium is quite rapidly precipitated on sheet zinc as sponge metal, and will accumulate on the sheets to the thickness of ¾ in. (2 cm.) before it becomes non-coherent. The cadmium sponge contains only a very small quantity of zinc, the average being 2 to 3 per cent.

Cadmium sponge can be thus precipitated from a neutral solution by means of metallic zinc, preferably in form of cathode sheets obtained from electrolytic zinc operations. These sheets are supported in a cylindrical tank with provision for agitating the solution by paddles. Provision is also made to prevent zinc scrap from falling to the bottom, where it would become mixed with the cadmium sponge.

With a high rate of agitation cadmium is galvanically precipitated as a semi-metallic coating and considerable effort and time are required to remove it. In this form it is very slowly soluble in the dilute sulphuric acid solution obtained from the electrolytic cadmium cells. Furthermore, if the paddle is sufficiently close to the bottom of the tank to rub against the accumulation of cadmium sponge, the sponge will be compressed into hard, flat pieces which have a semi-lustrous texture and are but slowly soluble in the final leach with acid cadmium electrolyte.

To overcome these difficulties, precipitation is performed in a cylindrical tank with properly supported zinc sheets. The paddles revolve at approximately 3 r.p.m. and there is a large clearance between the tank bottom and the paddle. This method produces a voluminous cadmium sponge on the cathode sheets ¾ to 1 in. (22 mm.) in thickness, which can be largely removed by shaking the sheets and almost completely removed with a stripping tool.

Apparatus Used

The apparatus used for carrying out the operation consists of a tank 6 ft. in diameter by 5 ft. in height (1.83 x 1.52 m.) holding 600 gal. (2,300 liters) of solution containing 80 g. zinc and 66 g. cadmium per liter. Two wooden racks hold with reasonable security a sufficient number of zinc sheets to precipitate the cadmium. The ratio of 1 sq.ft. superficial area per 3 gal. (1 sq.m. to 120 liters) of solution is satisfactory, although this can be varied according to local conditions. The zinc sheets are spaced 2½ in. (64 mm.) apart and are held in position by horizontal copper wires suitably placed. The floor of the rack is solid, as well as the sides to the depth of 4 in. (10 cm.), and prevent the fragile scrap from falling to the bottom of the tank. After these racks are loaded with electrolytic zinc sheets they are lowered by a chain block into the cadmium and zinc sulphate solution, being supported slightly above and clear of the paddle. This is mounted on a vertical shaft. Precipitation proceeds with a slow movement of the solution past the plates, When the solution becomes depleted in cadmium the racks are raised for complete cleaning of the zinc sheets, after which the sheets are replaced in the rack and lowered into the solution for the removal of substantially all the remaining cadmium. When the cadmium in solution has been reduced to a trace, the zinc content has increased from approximately 80 to 118 g. per liter. The zinc sulphate solution is then sent to the electrolytic zinc plant for the recovery of this metal.

Cadmium sponge is washed twice with warm water by decantation, drained and shoveled out of the tank. Hand removal of the sponge cadmium is necessary because it will not flow from the tank in suspension through a pipe, launder or even through a short nipple. The sponge is now ready to be charged into tanks for dissolving the cadmium by means of spent electrolyte.

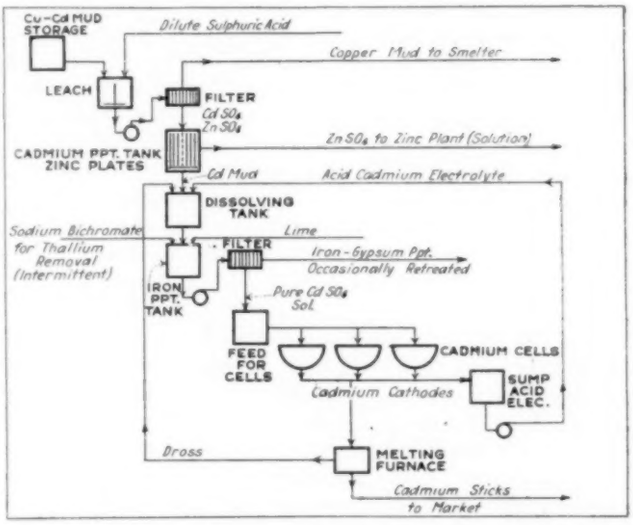


FIG. 1. FLOW-SHEET ELECTROLYTIC CADMIUM PLANT

Tanks used for dissolving the cadmium sponge are shallow, to facilitate stirring the mixture with a wooden hoe, this being done once or twice in eight hours. Three of these tanks, 6 ft. in diameter by 2½ ft. high (1.8 x 0.76 m.) are required for the production of 300 to 400 lb. (150 kg.) cadmium per day. The tanks are tightly covered and provided with a vent to the outside of the building, one half of the tank cover being hinged. In order to effect a rapid solution of the cadmium sponge, steam coils are placed within the tank and the temperature of the solution maintained between 50 and 60 deg. C. Cadmium sponge is charged into these tanks and acid cadmium electrolyte is added.

It is necessary that little or no arsenic be present at this stage, because of the likelihood that the workmen will breathe some of the violently poisonous gas of reaction. If arsenic is present in the original copper-cadmium precipitate, a modification of this procedure becomes necessary, which will be described later.

When a sufficient amount of solution, containing 90 to 100 g. Cd per liter, is accumulated, it is treated for the removal of iron. This is accomplished by the addition of hydrated lime, air agitation being used to cause

oxidation of the iron. The iron precipitate is separated from the pure solution by filtration, and the solution, if low in thallium, is delivered to the feed tank which supplies the electrolytic cells. When thallium has accumulated to a certain amount, the solution is treated for its removal.

Removal of Thallium

Thallium in amounts greater than 0.4 g. per liter has a decidedly detrimental effect on the character of the electrolytic cadmium deposit, and further causes an undue amount of oxidation of the cadmium in the melting operation. The element first made its presence suspected by the occurrence of a brown precipitate when making the routine acidity determination on the electrolyte. Its presence was then confirmed and a method developed for its removal.

Thallium resembles lead and manganese in some of its reactions and has two valences. The different characteristics of the lower and higher valence of the metal in solution have an important bearing on its separation from cadmium. Thallous compounds are not precipitated by hydrated lime, limerock or other bases, whereas cadmium is precipitated by almost all bases except limerock. Thallic compounds are precipitated by all of these bases. Thallic compounds are very easily reduced and the higher valence can be obtained only by strong oxidizing agents, such as potassium permanganate, bromine, iodine, etc., or by the anodic oxygen produced in the electrolytic cell. The higher form is transitory only and is slowly reduced on standing, after the effect of the oxidizing agent is gone.

Precipitation of cadmium by a base in presence of the soluble thallous salts is possible, but involves the handling of large quantities of cadmium precipitate. The removal of thallium in the thallic state by a base after electrolysis is not economical, because of the loss of acid which would be sustained, nor is it feasible, because of the indefinite valence of the element. In neutral solution thallous salts can be precipitated completely by sodium bichromate without producing any chemical effect on the cadmium, but cannot be precipitated from the solutions that are slightly acid. This gives a simple method of removing thallium from the solution before electrolysis as a chromate, and this step is performed when the metal has reached a concentration of 0.3 g. per liter. One pound of commercial sodium bichromate will remove approximately 1.36 lb. thallium.

Removal of Arsenic

In case arsenic is present in the original copper-cadmium precipitate, a modification of this procedure becomes necessary. The steps are substantially as shown heretofore, except the order of their sequence is changed. The new order is:

1. Leaching the arsenical-copper-cadmium-zinc precipitate with dilute sulphuric acid in a special manner, discharging arsine to the atmosphere.
2. Separation of the solution from the residual copper mud.
3. Addition of sufficient iron sulphate to combine with the arsenic and cause its removal from solution when the iron is oxidized and precipitated.
4. Precipitation of cadmium as sponge metal.
5. Solution of cadmium in acid cadmium-electrolyte.
6. Removal of thallium (when necessary).
7. Electrolysis.
8. Melting and boxing for market.

The precautions necessary in leaching the arsenical precipitate will consist in feeding the precipitate into the leaching tank so that the solids will remain in suspension in the neutral solution. The tank cover is closed tightly and dilute sulphuric acid added. The vent must be of ample size to carry away all the arsine to the outside of the building. If considerable arsenic is present a small fan may be used to insure positive ventilation.

To the arsenical solution sufficient iron sulphate is added to combine with the remaining arsenic. These two metals are then precipitated by lime in the presence of oxidizing agents and the mixture filtered. The arsenic-free cadmium-zinc solution is treated as described previously, with the exception that it is unnecessary to remove the iron; this step is described above.

General Notes on Electrolysis

Electrolytic deposition of cadmium has received considerable attention, especially with the object of overcoming the customary and troublesome "trees," sponge, sprouts and other objectionable forms in which it is deposited on stationary cathodes. The deposition of cadmium from neutral solution will not result in the formation of a metal-like deposit, but one that consists entirely of a spongy mass difficult to melt. In acid solutions a coherent deposit is formed, but it is always attended with a very large proportion of "trees," sponge and sprouts. Agitation of the solution does not improve the quality of the deposit. Rotating cathodes, however, have been found to give a smooth metallic cadmium deposit from acid solutions with very little or none of the irregular and undesirable forms.

In 1911-12 the rotating cathode was developed for electrolytic zinc at Bully Hill, Shasta County, Cal.

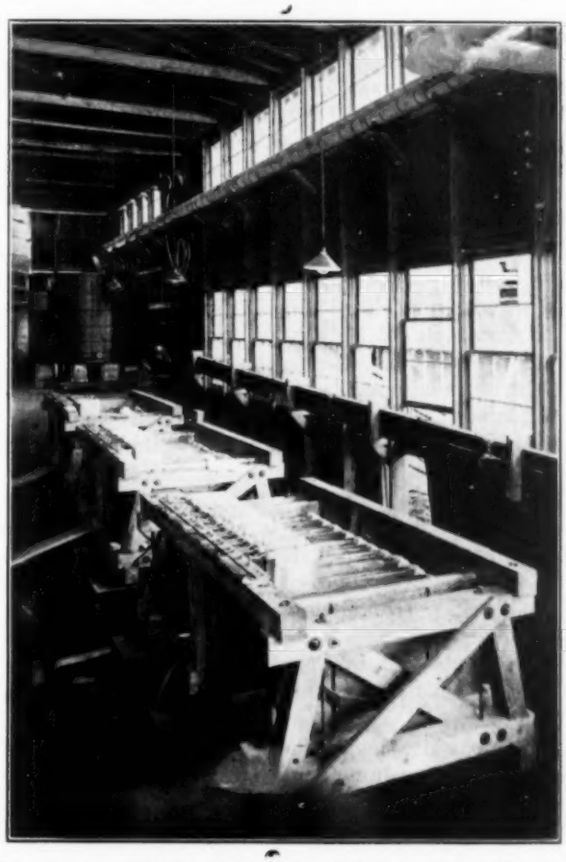


FIG. 2. CADMIUM CELLS, SHOWING SEMI-CIRCULAR ANODES IN PLACE

These were discarded because of mechanical difficulties and the excessive cost of stripping the zinc deposit. That type of cathode was used many years ago by Hoepfner in zinc chloride electrolysis. It was proved definitely at Bully Hill, however, that slowly revolving cathode disks would collect a greater weight of zinc per unit of area than stationary cathodes. Smoother and heavier deposits on the rotating cathodes result from the gas-free condition of the transitorily immersed cathode segment. A gas-free condition is caused by the hydrogen bubbles collecting on the surface of the cathode bursting when exposed above the solution. During zinc electrolysis in moderately acid solutions with stationary cathodes hydrogen bubbles accumulate on the cathode surface and the deposited metal takes on a honeycomb texture corresponding to the gas bubble surface. The honeycomb surface becomes irregular with the formation of sprouts or projections on the crests of the wart-like areas. If the bubbles are removed a smoother deposit naturally results.

In high-acid electrolyte, containing from 70 to 120 g. H_2SO_4 per liter, the physical condition of the zinc solution is such that these gas bubbles are automatically removed from the stationary plates to a large extent before they cause any serious effect on the cathode surface. But even with the proper operating acidity, the stationary plates cannot produce as heavy a deposit as the rotating disk. Electrolytic cadmium is sufficiently valuable to warrant the use of rotating disks, an operation which would not be feasible with lower-priced metals.

By placing double anodes in the cell—that is, two anodes for each cathode disk—the disks may be spaced at convenient distances apart, say 9 in. (23.5 cm.) from cathode to cathode. Large clearance permits easy stripping of deposits without the removal of shaft and disks from their position in the cells. The ages of the deposits are from 360 to 450 amp.-hr. per sq.ft. immersed cathode area, or 137 to 171 amp.-hr. per sq.ft. of total cathode disk (44 and 33 amp.-hr. per sq.m. respectively). The immersed cathode segment amounts to approximately 37 per cent of the entire disk. The above modification made the use of rotating cathodes for the production of electrolytic cadmium economical.

Another factor of economic importance will be considered: With only two cadmium cells in operation producing approximately 113 lb. (51 kg.) cadmium per cell per day, careful consideration must be given to the method of operation, because the usual practice standard for electrolytic zinc cell room will not be found suitable for the small cadmium plant. If two cells are fed continuously with but one passage of solution through the cells, the first cell would operate at half the acidity of the second cell, and the latter would operate under conditions approaching depletion of cadmium from solution. Therefore, half of the cadmium would be produced at the lower current efficiency common to the high-acid cell. In addition some supervision would be required either to regulate the feed or, if the solution was recirculated to the feed tank for repeated cycles through the cells, to look after pumps handling the acid electrolyte.

Operation with the double anodes implies the use of a cell having a volume approximately double that for regular anode installation. Because of the high ratio between the cell volume and the immersed cathode area, it is feasible to operate each unit as an accumulating acid cell. Such cells require no feed and the electrolyte gradually increases in acidity as the cadmium decreases in concentration. The building up process extends over twenty-four to thirty hours. Practically no attention is required except to fill the cells, strip the deposits and discharge the acid electrolyte. Average acidity in the cells is about one-half the end acidity, and the current efficiency approximately corresponds to that which would be obtained if the units were operated at the average acidity. For example, if the initial acidity were 10 g. and the final acidity 90 g. H_2SO_4 per liter, then 50 g. per liter would represent the average acidity at which entire deposition takes place.

Effect of Foreign Metals in Solution

In the production of cadmium, impurities in the electrolyte are to be avoided for obvious reasons. The effects of impurities in the relative order of their undesirability, placing the most objectionable condition first, would be:

1. Formation of sponge, "trees," sprouts and other irregular forms.
2. Corrosion of deposits.
3. Impurities in the deposit.

This order shows that the impurities are objectionable because of the effect on the physical condition of the deposit. This is significant because, in the presence of the irregular forms, deposition is attended with poor economy, involving high labor costs and very low current efficiency. The high labor cost is occasioned by very close attention and frequent stripping of deposits.

Corrosion of deposits is always present, but is greatly increased by irregular forms of the deposited metal. The rate of deposition on spongy or irregular areas is greatly reduced and the rate of corrosion considerably increased due to the more soluble condition of the metal as well as the increased area exposed to the attack. The sponge deposit referred to is not essentially different from the deposit obtained in the electrolysis of neutral solutions, although the latter is more porous.

The presence of zinc in solution up to 20 per cent of the amount of cadmium present has no effect either on the physical condition of the deposit or on the zinc content in the cathode cadmium. This was verified by the electrolysis of cadmium solutions to which addition of zinc sulphate had been made; the operation being performed in accumulating acid cells, using a solution containing 80 g. Cd and 16 g. Zn per liter. Depletion of the cadmium in solution was carried to 25 g. Cd per liter with practically no change in the initial zinc content. Analysis of the cathode cadmium obtained showed approximately 0.1 per cent zinc.

The common metals of the group which are precipitated by hydrogen sulphide in acid solution are to be avoided, as well as cobalt and nickel. The presence of 0.3 g. thallium per liter is especially detrimental, producing a dark sponge-like non-coherent deposit with a current efficiency between 40 to 50 per cent. Removal of thallium from the solution which is otherwise practically free from objectionable metals permits electrolysis in accumulating acid cells at a current efficiency of 85 per cent.

Impurities in Cathodes

While it naturally follows that certain impurities in solution will produce impure deposits, this is of minor importance compared with the low efficiency of cell operation resulting from their presence. In extreme cases solutions containing certain impurities will not

produce coherent cathode cadmium. On the other hand, solutions which produce coherent cathode deposits in most cases produce pure deposits. In other words, it is necessary to maintain pure solutions to obtain coherent deposits, and the production of impure cathode implies such non-coherent deposits that the operation would be uneconomical.

Cell Details

Electrolysis was carried on in two of three semi-circular lead-lined cells. The anodes were in shape of circular segments of considerably less than a half circle and were supported upon double-grooved porcelain blocks laid upon the lead lining of the cell. The anode was entirely submerged in the electrolyte except for that portion which extended through the surface of the solution to connect with the copper bars which in turn connected with the anode bus. There were two anodes for each cathode throughout the cell, the anodes being 2 in. (51 mm.) less in radius than the immersed portion of the cathode. Anodes and cathodes were spaced 2½ in. (64 mm.) centers and the distance between the two anodes as located by the porcelain blocks was 4 in. (102 mm.). This gave a clearance of 9 in. (229 mm.) between the cathode disks, which is ample to permit of easy stripping of deposits without removing the disks from the cell.

Cathodes consisted of $\frac{3}{16}$-in. (4.8-mm.) aluminum disks, 4 ft. (1.2 m.) in diameter. A hollow cast-aluminum hub distance-piece with an 11-in. (279-mm.) flange on one end was riveted to the center of each cathode with aluminum rivets on a 9-in. (229-mm.) circle. Each end of the aluminum hub was machined smooth, insuring a good electrical contact. The aluminum disks with hubs were slipped over a 4-in. (102-mm.) cold-rolled steel shaft and forced into contact by the pressure of large nuts threaded on each end of the shaft. This method of mounting the disks completely protects the steel shaft from corrosion by the acid electrolyte and provides good electrical contact between all disks. The assembled unit was placed in the cell and supported by two large bearings, oiled and insulated from their supports. At first the current was conducted to the cathode bus by means of a high conductivity bearing, operating without oil. This was found to heat materially and required some attention. A more satisfactory method of conducting the current from the shaft to the cathode bus consists of fitting a steel pulley on one end of the shaft. This is reinforced by radial copper strips and faced with copper sheet, and the current collected by high conductivity brushes which were placed in contact with the pulley face. To the other end of the shaft an insulated sprocket wheel was fitted. A chain drive revolved the cathode assembly approximately 1½ r.p.m.

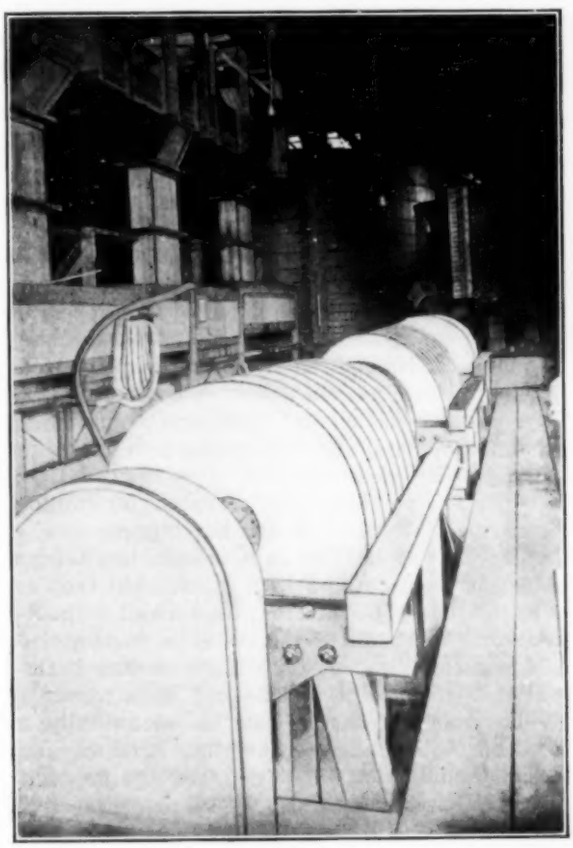


FIG. 3. CADMIUM CELLS, SHOWING ROTATING CATHODES IN PLACE

The cells hold 200 gal. (760 liters) of solution to a fixed line and immerse the cathode segment approximately 18.4 in. (467 mm.). This corresponds to approximately 8.8 sq.ft. (0.82 sq.m.) of superficial immersed cathode area per disk. There are nine disks in a cell, thus giving a total immersion area of approximately 79 sq.ft. (7.3 sq.m.).

Detail of Electrolysis

With a current of 1,200 amp. to each cell the effective current density is approximately 15 amp. per sq.ft. (163 amp. per sq.m.). A greater current density does not produce a smooth deposit. The theoretical yield of cadmium for 1,200 amp. per twenty-four hours amounts to 132.9 lb. (60.2 kg.). The average weight of cadmium deposit in twenty-four hours was 113 lb. (50.8 kg.), which corresponds to 85 per cent current efficiency. This amount corresponds to approximately 1.43 lb. deposit per sq.ft. per cathode disk per twenty-four hours (6.98 kg. per sq.m.).

Stripping the deposit was easily accomplished with a special tool.

The average emf. of the cadmium cells is usually close to 4 volts, commencing with a higher and finishing with a lower value. The increase in conductivity is caused by the increasing acidity of the electrolyte.

Each cell was put in operation following the discharge of the entire spent electrolyte from a previous charge, by filling the cell to the mark with neutral cadmium solution. This was slightly acidified with acid electrolyte. The cell was thus started in a slightly acid condition to avoid the initial spongy deposit which would be formed if started in neutral solution.

The drop in emf. between the electrodes and the cell lining in the semi-circular cadmium cells is different from what would be expected from similar measurement in an electrolytic zinc cell with stationary cathodes. Considerable attention was given to the insulation of the cells, busbars and other devices, but under most perfect conditions it was found that there was a large voltage drop between the anode bus, or any part of the anode system, and the lead lining of the cell. This drop, approximately 3½ volts, created a cathodic condition at the cell lining and caused some deposit to occur there. Owing to the extremely low current density of this partial cathode, by virtue of its large area, there was considerable corrosion of this deposit in the acid electrolyte, with the result that low current efficiencies were obtained. In fact practically all of the

cadmium which was deposited on the cell lining during the early stage (slight acidity) was corroded off during the highly acidic stage near the end of the cycle.

To overcome this partial cathodic condition of the cell lining small lead straps which would carry about 40 amp. were connected between the anode bus and the cell lining, thus creating a slightly anodic condition there. Before this connection was made, the emf. drops were: Anode to lining, 3.5 volts; cathode to lining, 0.5 volt. After connecting the lining to the anode bus, the emf. drops were: Anode to lining, 0.01 volt; cathode to lining, 4.0 volts. The creation of the anodic condition in the lining corrected the troubles described above. The cause of the original situation, however, was not clear, in view of the fact that the cells were quite perfectly insulated. It was thought that some condition allied to storage battery action in conjunction with the relative areas of the lining and the electrodes might possibly be responsible for this unusual emf. drop. The average emf. drop from electrodes to the lining in the cells of the electrolytic zinc department were as follows: (Zinc cell) anode to lining 1.9 volts; cathode to lining 1.7 volts; cell voltage 3.6.

The area of the lining per sq.ft. of effective cathode surface in the cadmium cell was 1.2 sq.ft. The corresponding figure for the zinc cell was 0.7 sq.ft. The above shows that the lining area per sq.ft. of effective cathode surface in the cadmium cell is approximately 57 per cent greater than in the zinc cell. The above relation might be considered, at least, in arriving at an explanation.

Power Required for Cadmium Deposition

There is 4.61 lb. (2.09 kg.) cathode cadmium theoretically deposited per 1,000 amp.-hr. With a current of 1,200 amp. the voltage of 4 at the cells, line loss 0.4 volt and motor generator efficiency 84 per cent, the total power required for two such cadmium cells, exclusive of transformer and main line losses, is:

$$24(1{,}200 \text{ amp.} \times 8.4 \text{ volts}) \div 0.84 = 288 \text{ kw.-hr. for 24-hr. operation.}$$

The cadmium produced in twenty-four hours will be at 85 per cent current efficiency: $2 \times 24 \times 4.61 \times 1.2 \times 0.85 = 226$ lb. (102.5 kg.) cathode cadmium.

The kw.-hr. required per lb. of cathode cadmium will be: 288 kw.-hr. $\div$ 226 Cd = 1.27 kw.-hr. per lb. Cd, or 2.80 kw.-hr. per kg. Cd.

Melting and Casting

The melting of the cathode cadmium into sticks for the market is an operation involving properly proportioned molds and skill on the part of the workmen. A successful method of melting cadmium was developed at the Midvale plant of the United States Smelting, Refining & Mining Co., and was substantially followed at the Kennett plant.

There would be considerable oxidation of the metal during melting of the cathodes unless special precautions were employed to exclude air as much as possible.

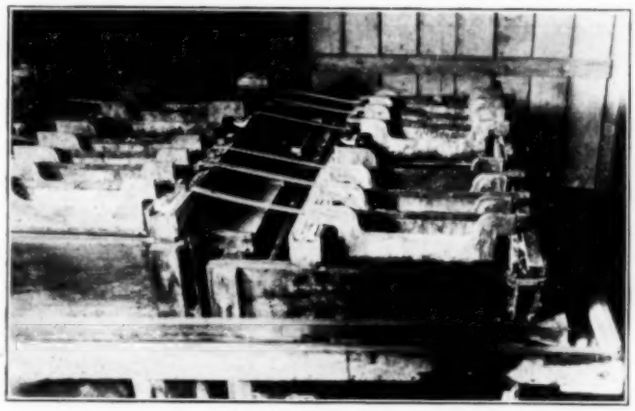
It has been found that best results are obtained by performing the melting operation in two stages: First, from cathodes to bars under heavy oil; second, from bars to sticks under caustic soda. Melting is done in cast-iron pots. The reason for the double operation will be apparent from the following: Cathode material is quite thin, approximately $\frac{1}{32}$ to $\frac{1}{16}$ in. thick (1 mm.). When these thin pieces are heated in the air, the large superficial area together with the marked tendency of the metal to oxidize causes a very large portion of the cathodes to be converted into oxide. Melting cathodes under a high flash point oil, such as 650 W. cylinder oil, accomplishes the first melting without excessive oxidation. There is sufficient latitude between the melting point of cadmium, which is approximately 325 deg. C., and the point at which the heavy oil will take fire in the pot to permit coalescence into a molten mass. For clean deposits it requires about 2 qt. of oil per 200 lb. of cathode (2 liters per 100 kg.). The oil in the pot is heated until white smoke begins to come off; the cathode sheets are then added as slowly as they melt. When 200 lb. of cathodes have been added, the oil will have been carbonized to a great extent and largely driven off, only a thin film remaining. The molten cadmium is poured into large molds. When the pot is nearly empty, the remaining oil is ignited by throwing a match into the pot, and the burning oil drops the major portion of the metal suspended in it into the molten mass below. The portion which cannot be ladled out is scraped from the pot and dumped on an iron plate. A considerable portion of this is recovered as shot or metallic slugs. The oxide produced is small in amount and free from oil. It is sent to the purifying department, where it is dissolved and again sent into the solution system.

REFINING FURNACES

The second melting for casting sticks is done in a separate pot under caustic soda and at a proper temperature. The latter is regulated by the appearance of the molten mass and further guided by the use of a pyrometer. It is not feasible to put the molten cadmium from the oil pot into the caustic pot direct, as there is always more or less oil and carbonaceous matter present in the molten metal and the casting into sticks must be done with very clean metal.

The ingots, weighing approximately 50 lb. (23 kg.), are charged into the caustic melting pot into which about 1½ lb. (0.7 kg.) of caustic soda has been added. The bars are not covered with caustic, but they melt on the bottom and slide into the fused alkali without much oxidation. When all of the metal is melted, the clean liquid caustic flows on top of the molten bath. The metal is then ready to be cast into stick form.

While cadmium ingots can be successfully melted under caustic, cathodes, on the other hand, cannot be so melted without undue oxidation and the production of a viscous shotty caustic-slag. The presence of a fluid, clean caustic-slag during the melting stage is of first importance because it is only with such a covering over the molten mass that successful stick casting can be



VIEW OF TANKS AT MIDVALE PLANT

accomplished. If the caustic-slag is thick and shotty, it is difficult to separate it from the metal in the special pouring ladle used for the final operation and either the ladle or the mold becomes clogged so that sticks cannot be successfully produced. The molten mass under the caustic is dipped out with a specially shaped ladle designed to hold back the molten caustic.

Cadmium sticks of commerce are about $\frac{7}{16}$ to $\frac{11}{16}$ in. (8.3 mm.) in diameter and 12 in. long (300 mm.). The mold designed to produce this size of stick is of special construction, containing seventeen smooth cylindrical holes, coinciding with the dimensions of the sticks and also a gate extending across the entire top communicating with all the holes. The mold is split along the longitudinal axis of the sticks.

There is a critical temperature in the cooling of molten cadmium when it becomes pasty and fragile and it is only with the utilization of this property that successful casting can be carried out. Molten metal is poured into the mold, previously heated, through a gate which is larger in diameter than the individual cylindrical holes, thus providing a relatively large volume of metal solidifying in the gate. After the metal has cooled sufficiently the mold is opened, the sticks broken away from the metal on the gate and removed for trimming and boxing. Waste metal, together with a small amount of incidental scrap, is remelted. By proportioning the size of the gate to permit of a sufficient mass of metal in the gate, compared to the mass of the sticks, the transitory fragile condition of the metal at the junction of the sticks and gate is of longer duration, giving sufficient time to insure the cooling of the sticks to a tough condition while the junction is pasty and fragile. This also gives sufficient time for the operator to make his observations, open the mold and break the sticks from the gate. The sticks are trimmed to remove any thin projections and packed in a double box holding approximately 100 lb. (45 kg.). The sticks must be free from coating, smooth, and of full length.

Losses in Melting

Losses in melting vary with the experience and skill of the operator. A practical man who works carefully can perform the two stages of melting with but little loss of metal, and do the work economically as regards time. Melting loss from clean cathodes to bars will amount to approximately 3 to 4 per cent under very good conditions, but the average loss may exceed this and amount to 4 to 8 per cent. This loss is represented by oxide and shot, all of which is sent to the dissolving tank, where it is recovered. The melting loss from bar to stick cadmium will amount to approximately 1 to 3 per cent under good conditions. The average may exceed this and reach 3 to 5 per cent. This loss is also recovered by sending the oxide dross to the dissolving tanks in the purifying department.

The time element involved in the production of 400 lb. (180 kg.) stick cadmium may be stated in the number of man-hours, showing the per cent of the total required by each department:

	Man Hours	Per Cent
Leaching, purification and other solution preparation	26	41
Cell room operation, including stripping	5	9
Melting to bars	8	12.5
Melting to sticks and casting	16	25
Trimming, boxing and general work	8	12.5
Total	63	100

Statistics

Increase in the demand for cadmium between 1914 and 1917 inclusive stimulated production by plants already operating on a small scale. In 1914 approximately 91,000 lb. of metallic cadmium was produced in the United States, and this increased to 207,000 lb. in 1917. A decrease in production was manifest in 1918; figures collected by C. E. Siebenthal show that approximately 127,000 lb. was produced. The following figures compiled by the same authority represent the quantity of cadmium sulphide produced in the United States during the same period:

1914	22,700 lb. cadmium sulphide pigment, dry
1915	10,600 lb. cadmium sulphide pigment, dry
1916	22,000 lb. cadmium sulphide pigment, dry
1917	51,000 lb. cadmium sulphide pigment, dry
1918	51,700 lb. cadmium sulphide pigment, dry

The average price for the metal from 1907 to 1914 inclusive was 71c. per lb. and from 1914 to 1918 inclusive $1.42 per lb. The average price for the cadmium sulphide from 1914 to 1918 was $1.25 per lb., figures which correspond to $1.60 per lb. for the cadmium contained in the pigment.

Uses of Metallic Cadmium

The low melting point of cadmium renders it useful in the production of low melting point alloys used in the manufacture of fusible plugs in sprinkler systems designed for fire protection. Abstracts from the *Brass World*, of the year 1908, page 352, show that cadmium is useful as a bearing metal. U. S. Patent 89743, September, 1908, by Enrique Touceda, describes certain mixtures containing lead and cadmium. This inventor advocates the following mixtures for bearings:

	Pb	Cd
For cheap work and light loads	97.25	2.75
For general and ordinary work	92.00	8.00
For bearings, subject to shock	89.00	11.00
For armature pin ends	86.00	14.00
For extremely severe loads	82.00	18.00

Prof. Touceda states that hardness and fine grain are obtained by the use of lead-cadmium alloy. In this respect it differs from antimony, which not only causes coarse grain but decreases the ductility of the lead. Other anti-friction cadmium alloys were used by this inventor, involving magnesium, mercury and bismuth. Claims were made that magnesium hardens the alloy without destroying the ductility produced by the cadmium. Mixtures of the following compositions were cited: (1) Pb 85, Cd 10 and Mg 0.1 to 5 parts, and (2) Hg 5.3, Bi 5 and Cd 42 parts.

Cadmium statistics collected by Siebenthal in 1918 show that the use of this metal in the manufacture of solders has received some attention. This was of special interest during the war, when in the first three-

quarters of the year 1918 there was a scarcity of tin. It was known early in the war that the Germans, without resources in tin but with a fair supply of cadmium, were substituting that metal for tin. It is now known that solders with 10 per cent Cd and 10 per cent Sn were used and the cadmium content in other solders ranged as high as 30 per cent Cd with 2 per cent Sn.

This authority quotes the following solder composition:

Parts Pb	Parts Cd	Parts Sn	Melting Range Deg. C.
84.4	7.6	5	212–253
90.6	7.9	1.5	237–267
87.5	7.5	5	235–368

The cost of materials for tin and cadmium solders of various formulas, Oct. 1, 1918, is shown in Table II. At these prices solder composed of 80 parts of lead, 10 parts of tin and 10 parts of cadmium can be made as cheaply as half-and-half solder with cadmium at $3 per lb. At the close of 1918, with a lower price for tin and lead, the price of the foregoing combination is as shown in Table III. With the average prices before the war of about 4.5c. per lb. for lead, 35c. per lb. for tin and 80c. per lb. for cadmium, the foregoing solders would cost respectively, 19.7c., 16.7c., 15.1c. and 10.5c. a lb. for the raw materials.

TABLE II. COST OF MATERIAL IN 100 LB. SOLDER, AS OF OCT. 1, 1918

Lead 8.05c., Tin 80c., Cadmium $1.50 per lb.

	50Pb-50Sn	60Pb-40Sn	80Pb-10Sn-10Cd	92Pb-8Cd
Pb	$4.03	$4.83	$6.44	$7.41
Sn	40.00	32.00	8.00	.....
Cd	.....	.....	15.00	12.00
	$44.03	$36.83	$29.44	$19.41

TABLE III. COST AT CLOSE OF 1918

Lead 5.75c., Tin 69c., Cadmium $1.50 per lb.

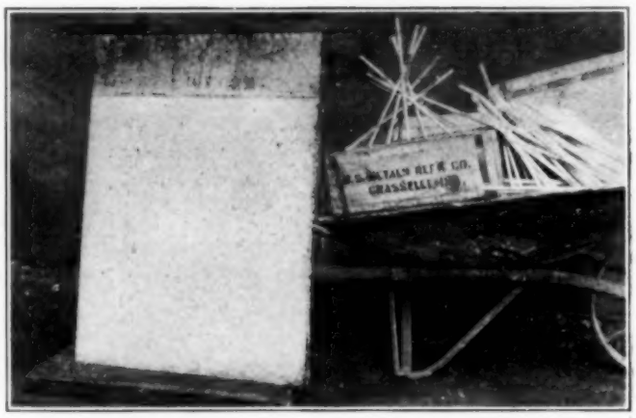
	50Pb-50Sn	60Pb-40Sn	80Pb-10Sn-10Cd	92Pb-8Cd
Pb	$2.88	$3.45	$4.60	$5.29
Sn	34.50	27.60	6.90	.....
Cd	.....	.....	15.00	12.00
	$37.38	$31.05	$26.50	$17.29

It is further cited that cadmium is a better rust preventive than nickel. A cadmium band fitted to a projectile is said to take the rifling with little wear.

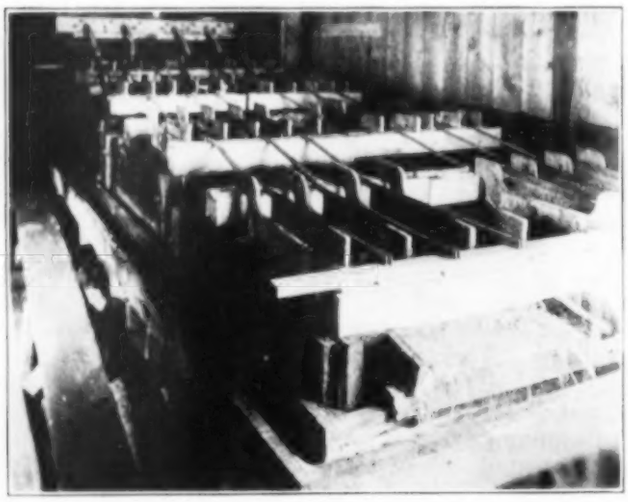
Uses of Cadmium Compounds

It is believed that the pigment industry offers a good prospective field for the consumption of cadmium compounds. Cadmium yellows and cadmium lithopone constitute the principal form used and the persistence of the color is a favorable feature of these pigments. They can therefore be used advantageously in an atmosphere vitiated with sulphur smoke, whereas the chrome yellows darken under similar conditions. Cadmium has long been used by artists who require beautiful and persistent yellow or orange tints. The sulphide, which is the form used in paints, will stand considerable dilution with a transparent thinner, such as heavy spar, without losing the intensity of the yellow color. It may be possible, therefore, to develop a color using this pigment that could compete in price with cheaper yellows. This proposition would require development by experienced paint chemists in order to be definitely established. The shade of color can be quite accurately controlled from light yellows to deep vermilions by regulating by hydrogen sulphide the acidity of the cadmium sulphate solution from which it is precipitated. Consequently the color required by the trade could be consistently duplicated.

San Francisco, Cal.



ANODES AND STICKS READY FOR SHIPMENT



ANOTHER VIEW OF CASCADED TANKS AT MIDVALE PLANT

Trade of Philippine Islands in Vegetable Oils and Vegetable-Oil Material

The following statement gives statistics on the imports and exports of vegetable oils and vegetable-oil material by the Philippine Islands during 1917, 1918 and 1919:

Commodities	Quantity	Value
Vegetable Oils:		
Oils, fixed or expressed—		
Castor oil—		
Imports—	Gal.	Pesos*
1917	20,654	39,255
1918	18,679	60,577
1919	44,811	158,306
Linseed oil—		
Imports—		
1917	58,355	114,802
1918	157,122	436,028
1919	90,202	234,191
Olive oil—		
Imports—		
1917	38,963	105,931
1918	13,684	59,254
1919	32,649	135,261
Peanut oil—		
Imports—		
1917	167,027	221,430
1918	134,283	248,381
1919	156,925	345,861
All other fixed or expressed oils—		
Imports—		
1917	.....	72,170
1918	.....	62,840
1919	.....	114,810
Candlenut oil—		
Exports—	Pounds	
1918	406,590	129,238
1919	305,602	92,843

Commodities	Quantity	Value
Vegetable Oils—Contd.		
Cocoanut oil—		
Exports—	Lb.	Peso
1917	99,644,426	22,818,294
1918	254,148,155	63,328,317
1919	308,517,482	73,719,504
Sesame oil—		
Exports—		
1918	13,774	1,250
Vegetable oil material:		
Peanuts—		
Imports—		
1917	2,447,247	208,777
1918	2,200,343	279,907
1919	2,284,204	387,932
Copra—		
Imports—		
1917	68,206	2,412
1918	1,845,810	125,105
1919	58,362,330	5,425,560
Exports—		
1917	203,220,747	16,654,301
1918	121,389,103	10,377,029
1919	55,322,292	8,839,376
Sesame seeds—		
Exports—		
1917	372,308	27,558
1918	266,320	30,661
1919	307,449	37,596

* The peso equals 50c.

The Engineering Profession and Government Technology

The Need for Increasing the Salaries of Government Professional Employees Is Brought Out by the Enumeration of a Series of Facts on Conditions Now Existing in the Different Government Technical Bureaus

BY R. S. McBRIDE*

WHETHER they know it or not, the engineer and the chemist are seriously concerned with the fate of the technical and professional work being done by the Federal Government. In the first place, the quality of this work affects industries in which all engineers and chemists are vitally interested. In the second place, the engineering and chemical professions as a whole are judged in part by the characteristics of the Government employees who bear corresponding titles.

There is perhaps no more debatable question in the whole field of professional activity than where to draw the line between governmental activity and business. However, this question does not need to be discussed here, for without regard to whether one thinks the Government should do more than now or less than now it is of great importance to know how well the Government is going to do that which it undertakes in science and engineering.

Congress, business men and the general public hear much more of the activities of Government engineers and Government scientists than they do of the corresponding activities of those engaged by corporate interests or those practicing privately. Necessarily, therefore, the legislators and the public judge the type by those examples most conspicuously before them. If Government chemists are men of high standing, of large ability and strong in their adherence to sound professional practice, chemists by and large through the country will be correspondingly benefited. If, on the other hand, this or any other group of Government scientists indulges in bad professional habits, or for any other reason falls into disrepute before our national legislators or before the public, there is a reaction of corresponding disadvantage to the profession as a whole. This alone would be justification for serious thought with respect to the technical professional services and their future.

There is another equally potent reason for immediate attention to Government technical affairs. Industry inevitably deals with Government in one relation or another. Business and industry, particularly technical business and chemical industry, will inevitably go to the Government for much of vital concern in their everyday operations. They will continue to depend largely upon Government mineral-resource statistics and upon Government reports of commodity production and market tendencies. We shall expect a continuance by the federal departments of certain vital mineral and agricultural investigations and important studies of fundamental principles. The Government affords a means for such researches into technology and science that cannot readily be afforded elsewhere. We want a continuance of the studies of tariff. We must have statistics of manufactures, such as our census regularly supplies, and inevitably the Interstate Commerce Commission, the Federal Trade Commission, the Bureau of Foreign and Domestic Commerce and other administrative agencies of merit will be conducting investiga-

*Engineering Representative, McGraw-Hill Co., Inc., Washington, D. C.

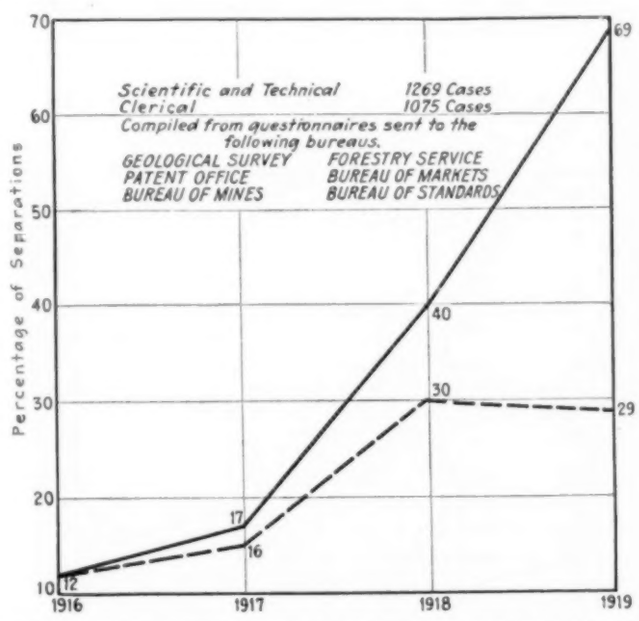


FIG. 1. DISTRIBUTION OF SEPARATIONS ACCORDING TO NATURE OF SERVICE

TABLE I. SEPARATIONS FROM GOVERNMENT SERVICE FOR FISCAL YEARS 1916 TO 1919, INCLUSIVE

	1916			1917			1918			1919		
Bureau	Roll	Separations	Percentage	Roll	Separations	Percentage	Roll	Separations	Percentage	Roll	Separations	Percentage
Geological Survey:												
Scientific...	422	43	10	420	57	14	435	81	19	460	126	27
Clerical....	191	49	25	190	42	22	248	70	28	210	42	20
Patent Office:												
Technical...	377	23	6	377	36	10	387	92	24	387	82	21
Clerical*...	560	51	9	575	88	15	591	179	30	565	95	17
Bureau of Mines:												
Scientific or Technical...	...	..	..	...	..	..	23	12	52	26	7	27
Clerical....	...	..	..	...	..	..	117	31	26	144	30	21
Forest Service: Administrative, Scientific, Technical and Professional.....	93	6	6	98	5	5	84	11	13	87	18	21
Clerical....	125	7	6	126	10	8	113	26	23	111	16	14
Bureau of Markets:												
Scientific...	107	4	4	220	13	6	217	46	21	323	103	32
Clerical....	149	10	7	331	28	8	516	133	26	917	253	28
Bureau of Standards:												
Scientific...	270	75	28	338	133	39	676	492	73	609	976	161
Clerical....	50	13	26	61	25	50	159	91	57	159	181	114
All Bureaus:												
Scientific*..	1,269	151	12	1,453	245	17	1,822	734	40	1,892	1,314	69
Clerical....	1,075	130	12	1,273	193	15	1,744	530	30	2,106	617	29

* Includes a few not strictly clerical workers.

TABLE II. SALARY ADVANCE OF SCIENTIFIC, TECHNICAL, PROFESSIONAL EMPLOYEES UPON LEAVING THE GOVERNMENT SERVICE

Bureau	No. of Employees	Average Salary Before Leaving	Average Salary After Leaving	Average Advance Over Govt. Salary	Average Per Cent Increase Over Govt. Salary
Treasury:					
Supervising Architect	27	$1,603	$2,386	$783	49
War:					
Ordnance	70	1,446	1,927	481	33
Navy:					
Construction and Repair	13	2,360	4,311	1,451	51
Conservatory	18	1,164	1,567	403	35
Yards and Docks	28	2,176	2,734	558	26
Steam Engineering	6	2,099	2,636	537	26
Interior:					
Education	11	2,864	4,640	1,776	62
Geological Survey	47	2,007	4,157	2,150	107
Indian Affairs	8	1 525	3,313	1,788	117
Land Office	8	1,503	2,258	755	50
Mines	66	2,234	4,548	2,314	104
Patent Office	152	1,828	2,439	611	33
Agriculture:					
Animal Industry	26	2,006	2,780	772	38
Biological Survey	3	1,662	2,200	538	32
Chemistry	98	2,062	3,275	1,213	59
Entomology	36	1,551	2,021	470	30
Farm Management	13	1,865	2,292	327	23
Fed. Horticulture Brd.	4	1,950	2,279	329	17
Forest Service	99	1,769	2,737	968	55
Markets	71	2,066	3,498	1,432	69
Plant Industry	98	1,735	2,621	886	51
Publications (Illustrations)	2	1,400	2,400	1,040	74
Public Roads	16	2,521	4,012	1,491	59
Soils	14	2,217	3,876	1,659	75
States Relations	10	2,597	3,301	704	27
Commerce:					
Coast and Geodetic Survey	55	1,090	1,399	309	28
Lighthouses	5	1,680	3,124	1,444	86
Standards	41	1,854	2,479	643	34
Labor:					
Naturalization	3	1,267	2,283	1,016	80
Smithsonian Institution	2	2,400	4,900	2,500	104
I. C. C.:					
Carriers' Accounts	83	2,576	3,523	947	37
Inquiry	8	3,863	8,175	4,312	112
Statistics	16	1,658	2,444	786	47
Federal Board for Vocational Education	7	4,429	4,979	550	12
International (Canadian) Boundary Commission	9	2,682	5,344	2,662	99
General average	1,173	1,806	2,761	955	53

tions and issuing regulations of vital concern. One can readily imagine what will happen if adequate attention is not given to science and technology by these many agencies. An official poorly advised or out of sympathy with the technical problems cannot be expected to give best service, and a petty man in a big job is a danger to all elements of business. It is essential, therefore, that technical men in all branches find out what kind of technologists are to be active in Government affairs either as the advisers of administrative officials or as administrative officials themselves. Better no researches at all than those of the half-baked, poorly directed, ill-advised variety. And, too, better no statistics at all than wrong statistics.

All this points to a very simple moral—we must be much concerned with the standards maintained in the technical and scientific personnel of our federal agencies. Just now we can well be alarmed over the tendencies in these staffs. Without lengthy discussion, the accompanying summary by chart and tabulation presents the situation.

Table I,[1] which is in part presented also by Fig. 1, shows the separations from the Government service of

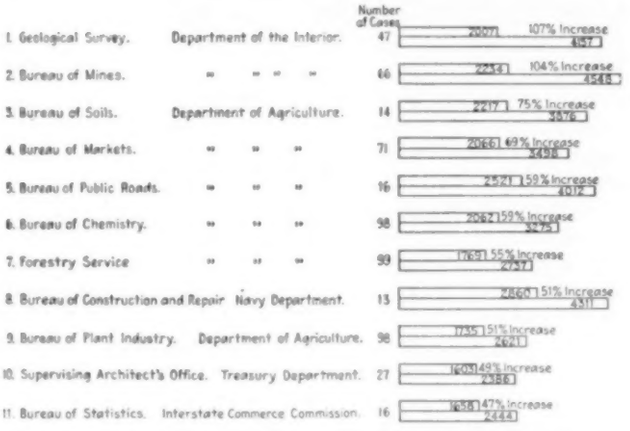

Number of Cases
1. Geological Survey. Department of the Interior. 47 2007 107% Increase 4157
2. Bureau of Mines. " " " " 66 2234 104% Increase 4548
3. Bureau of Soils. Department of Agriculture. 14 2217 75% Increase 3876
4. Bureau of Markets. " " " 71 2066 69% Increase 3498
5. Bureau of Public Roads. " " " 16 2521 59% Increase 4012
6. Bureau of Chemistry. " " " 98 2062 59% Increase 3275
7. Forestry Service " " " 99 1769 55% Increase 2737
8. Bureau of Construction and Repair Navy Department. 13 2860 51% Increase 4311
9. Bureau of Plant Industry. Department of Agriculture. 98 1735 51% Increase 2621
10. Supervising Architect's Office. Treasury Department. 27 1603 49% Increase 2386
11. Bureau of Statistics. Interstate Commerce Commission. 16 1658 47% Increase 2444

FIG. 2. SALARY ADVANCE OF SCIENTIFIC, TECHNICAL AND PROFESSONAL EMPLOYEES UPON LEAVING THE GOVERNMENT SERVICE

technical and clerical employees during four recent fiscal years. Accurate data for the last fiscal year, 1920, are not available, but approximate figures show that only a slightly smaller percentage of separations in the technical services occurred than in 1919. In other words, the large number of separations in the fiscal year 1919 which naturally resulted from a termination of hostilities is being continued and the alarming depletion in the technical services is not yet halted. More-

[1]These data and charts were prepared by Dr. C. D. Jarvis, Bureau of Education, for the Commission on Reclassification of Government Salaries.

TABLE III. RATE OF SALARY ADVANCEMENT OF SCIENTIFIC, TECHNICAL, PROFESSIONAL EMPLOYEES BEFORE AND AFTER LEAVING THE GOVERNMENT SERVICE

		In the Government Service					After Leaving Government Service				
Bureau	No. of Cases Considered	Average Initial Salary	Average Salary at Leaving	Average Length of Service Yr.	Mo.	Average Increase per Year	Average per Cent Increase	Average Salary Accepted	Average Present Salary	Average Length of Service Yr.	Mo.	Average Rate of Increase per Year	Average per Cent Increase
Superintendent-Architects	11	$1,102	$1,573	7	..	$65	6	$2,245	$3,822	4	9	$332	15
Observatory — Naval	14	948	1,193	3	7	77	8	1,650	3,629	5	2	383	23
Bureau of Education	11	2,455	2,864	4	6	91	4	4,640	5,231	3	1	192	41
Geodetic Survey	47	1,038	2,006	7	6	128	12	4,157	6,238	1	9	1,190	29
Survey Division (Land Office)	4	1,540	1,455	4	..	24	2	2,000	3,300	11	..	118	6
Bureau of Mines	11	3,075	3,366	2	7	113	4	6,715	10,550	1	6	2,556	38
Patent Office	136	1,363	1,838	6	1	78	6	2,450	4,964	5	8	443	18
Animal Industry	26	1,555	2,007	4	9	95	7	2,780	3,002	..	8	333	12
Biological Survey	3	1,067	1,662	4	4	137	13	2,300	2,400	1	2	172	78
Bureau of Chemistry	48	1,444	2,064	5	..	124	8	3,016	3,980	1	10	372	17
Bureau of Entomology	36	1212	1,551	2	6	136	11	2,021	2,185	1	..	164	8
Farm Management Office	12	1,515	1,850	3	6	96	6	2,383	2,545	1	9	92	4
Federal Horticultural Board	4	1,950	1,950	1	2	0	0	2,279	2,369	..	7	156	7
Forest Service	30	1,044	1,775	5	3	139	13	2,301	4,062	5	2	340	15
Bureau of Plant Industry	41	1,441	1,883	4	..	110	3	2,855	4,116	3	8	344	12
Public Roads	3	1,640	2,513	5	11	147	9	3,333	5,500	1	8	1,300	39
States Relations Service	10	2,122	2,597	4	2	114	5	3,301	3,715	1	..	414	13
Coast Survey	36	984	1,156	2	11	59	6	1,426	2,696	8	10	144	10
Bureau of Standards	38	1,253	1,887	3	7	178	14	2,540	2,813	..	8	410	16
Bureau of Naturalization	3	833	1,266	4	2	104	12	2,283	3,266	3	8	268	12
Bureau of Carriers Accounts I. C. C.	64	1,943	2,530	4	9	124	6	3,298	6,190	4	8	619	19
Bureau of Inquiry I.C.C.	6	1,470	3,950	8	..	310	21	7,400	7,900	1	4	376	5
Federal Board for Vocational Education	7	4,214	4,429	1	3	175	4	4,979	5,050	..	5	170	3
Internat (Can.) Boundary Commission	6	1,834	2,473	5	5	118	6	5,267	4,950	1	5	223	4
Agricultural Publications (Sec. of Illstr.)	2	1,020	1,400	5	8	68	7	2,440	2,798	2	11	123	5
Total	609	1,456	1,987	4	10	110	8	2,880	4,458	3	8	430	15

over, the more valuable men are often, if not always, the ones who are leaving.

The only significant point which need be mentioned as a cause of this large number of separations is shown by the figures in Table II, illustrated graphically in part by Fig. 2. These show the salary advances of scientific and technical workers upon leaving the Government service. Not all of the cases of separations can be set forth, as data are not available for each case, but a sufficient number of cases are here presented to make clear the general situation.

As a corrollary to salary changes we must of course consider the cost of living. Fig. 3 sets forth in striking manner the relation between the number of separations from the Government service (where more or less fixed salaries prevail) and the costs of living. The two curves, it will be seen, do not follow each other exactly, but the general trend since 1913 and 1914 is very significant indeed.

The rate of salary increase within the Government service and the corresponding rate of salary advancement by men after leaving the Government service are also important matters. A comparison for 600 cases has been made in the data set forth in Table III. The fact that approximately four times the increase per year has been found after leaving the Government

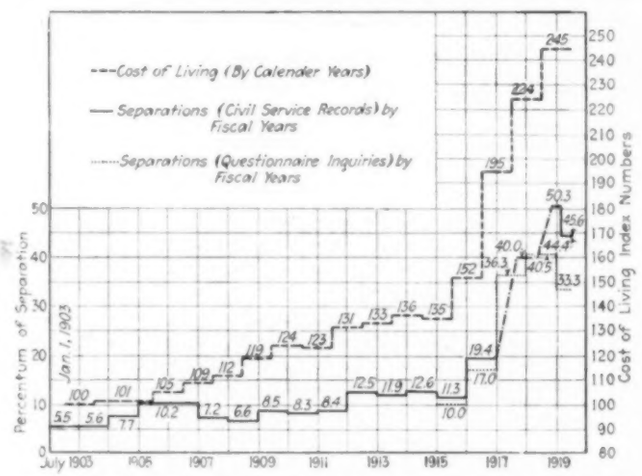


FIG. 3. RELATION BETWEEN COST OF LIVING AND SEPARATIONS FROM GOVERNMENT SERVICE

service as in the service is very significant. Because of the higher actual salary the percentage increase is only approximately double outside as inside. At the rate of increase normal in the Government it would require more than twenty-seven years to reach the average outside salary level reported, whereas this same increase is accomplished in approximately eight years under commercial conditions.

That the situation is regarded as critical in Washington should be recognized. The various Cabinet officials are urging a decided increase in the technical and professional salary scale, though they are hesitating under present conditions to urge large corresponding increases for the clerical staffs of the Government services, which are of course much more numerous. In connection with any consideration of this point it is worth while to notice the probable cost of salary increases. There are approximately 10,000 technical and scientific persons in the Government employ in Washington. A salary increase of $1,000 per year for each of these workers (which is more than expected or ever asked) would amount to less than 10c. per capita for the United States. The cost of remedying this particular condition would be much less than this; indeed, it would be an inappreciable factor in affecting either the cost of living or the federal taxes. One single serious technical error of judgment might cost the country as a whole much more than the total of such munificent salary increase.

Industry and professional workers generally may well take steps immediately to urge an amendment of these conditions, which so vitally affect their particular interests. The general public needs also be concerned. Means for correction of this condition are to be found solely through action of Congress. Communications in the interest of improvement of the federal technical service can, therefore, well go to the Congressional Representatives or the Senators with whom one is acquainted or they may be addressed to the Committee on Appropriations of either house of Congress, or to the directors of the technical bureaus in which interest is held. Let us insist that such work as technical Government workers are asked (or permitted) to undertake is well done.

Dividivi Production in Mexico

Dividivi is a tree native to Mexico from the seeds or pods of which tannin is extracted. Although cheap in price, the tannin obtained from dividivi does not give the best results in the dyeing industry, states Assistant Trade Commissioner Noll, who has supplied the report. This tree, which is known in Mexico under the name of cascalote, reaches a height of from 20 to 30 ft. and grows wild in damp, marshy places. Probably it thrives best in the State of Guerrero. The tannin is found in pods about 3 in. long and ¾ in. broad, which are gathered by peons and transported on mules to the railroad. These gatherers receive from 50 centavos to one peso (1 peso = 0.4985 U. S. currency) per day, and the pods are sold at from 16 to 20 centavos per lb. There are no organized methods of gathering and handling the pods. The tree is ready to bear at two years of age and continues producing until it dies; mature trees yield from 40 to 75 lb. of dry pods annually. The pod, which is dark brown in color, contains from 40 to 50 per cent tannin in its tissues, whereas very little tannin occurs in the seeds. It is estimated that 95 per cent of the dividivi produced in Mexico is sent to the United States. In the fiscal year ended June 30, 1914, there was exported from Mexico to the United States 24,000 lb. Statistics of exports for the last few years are not available.

Bourbon Vanilla Production

The production of vanilla beans in Madagascar and dependencies, including the Comoro Islands, and in the islands of Reunion and Mauritius for the season 1920-21, has been officially estimated as follows:

Madagascar and dependencies:	Lb.
Comoro Islands	553,355
East Coast	498,184
Nossi-Be	99,207
Total	1,150,746
Mauritius	1,102
Reunion	176,368

Although official statistics have not been received concerning the Seychelles Islands, it is understood that the production in that archipelago will not be greater than, and probably not as great as, that of last season, which amounted to only 6,614 lb. of cured beans.

Synopsis of Recent Chemical & Metallurgical Literature

British Research on Automobile Steels.—The Institution of Automobile Engineers, 28 Victoria St., S. W., London, has recently issued in book form a compilation of a very exhaustive series of tests, each made by three independent investigators, upon the tensile properties, impact strength and hardness of ten different steels much used in British automobile construction. The work was co-operative on the part of many steel makers and consumers, and has been under way for six years. J. H. S. DICKENSON, a prominent member of the committee in charge, has commented upon certain phases of the work in *The Engineer* for Nov. 12 and 19, from which the following notes are taken:

Only the lower half of ingots were used, thus eliminating almost completely the effects of unsoundness. Still very marked discrepancies in test results were sometimes reported, showing clearly that even in the hands of well-known investigators the heat-treatment of a small bar is not always accurately done.

From the mass of data at hand, Mr. Dickenson selects some tests on 0.15-carbon case-hardened steels marked 2H and 2L, whose analyses follow:

	2H	2L
Carbon	0.20	0.12
Silicon	0.11	0.05
Manganese	0.99	0.71
Sulphur	0.066	0.080
Phosphorus	0.049	0.048

A series of tests determined the effect of mass upon the properties after quenching in water from 900 deg. C. (1,650 deg. F.) and tempered at various temperatures. Plotted results show well-defined maxima and minima. A peak on the Izod impact curve for 2L at a 1⅛-in. diameter bar perhaps marks a size above which water-quenching is not sufficiently rapid to prevent separation of free ferrite. Comparison between these curves for the 6 per cent nickel case-hardening steel of 2½-in. diameter and a 0.35-carbon case-hardening steel of ½-in. diameter shows the two samples to have approximately the same ultimate and impact strength when quenched in cold water. It is therefore apparent that small parts of high strength may be made from heat-treated plain carbon steels without resorting to the more expensive alloys. This is an indication of the immense commercial importance to which a systematic investigation of this sort can be put.

The 0.35-carbon case-hardening steels mentioned above had compositions as follows:

	6H	6L
Carbon	0.45	0.26
Silicon	0.32	0.20
Manganese	0.78	0.50
Sulphur	0.02	0.06
Phosphorus	0.025	0.065
Nickel	——	0.03

Experimenting upon 6H by quenching in oil and in water and then drawing at different temperatures, it was seen that a sharp inflection in the strength and ductility curves occurred at a lower temperature in the water-quenched samples than in the oil-quenched curves, for the two treatments converged at 700 deg. C. (1,290 deg. F.), as would be expected by complete breakdown of all pre-existing solid solution. However, the impact strength of water-quenched bars, although lower than oil-quenched when tempered below 500 deg. C., becomes higher with high-temperature drawing, and remains decidedly higher even after reheating to 700, perhaps due to the fact that it was originally harder, and more toughness could in general be had from the harder bars.

Comparing steel 6H with 6L after identical heat treatments, it is found that the tensile properties vary slightly in a way which may be ascribed to the difference in composition. The reductions in area curves are closely alike after tempering at 700 deg. C. (1,290 deg. F.), but the impact strength for the harder steel is much higher; so much higher than usual, in fact, that

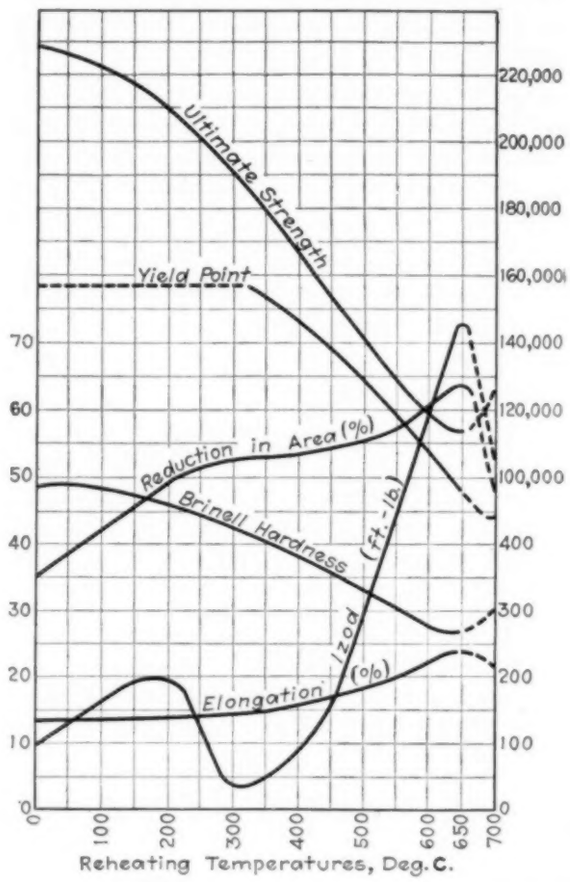


FIG. 1. PROPERTIES OF A NICKEL: CHROMIUM STEEL

Mr. Dickenson thinks it to be due to some unknown original structural character of this particular ingot or to the method of working.

Nickel: Chromium Steel.—Steel 9H, analyzing C 0.31, Si 0.14, Mn 0.70, S 0.027, P 0.030, Ni 3.27, Cr 0.82, was reheated after oil-hardening with the results shown in Fig. 1. The impact strength curve had already been repeatedly confirmed by several investigators independently, but it has been agreed that it does not occur in all samples of nickel: chromium steel to anything like an equal degree, even with slightly varying compositions. Still it is usually recognized that reheating temperatures between 250 and 450 deg. C. (480 to 840 deg. F.) should be avoided. It is not so well known that tempering at 200 deg. C. (390 deg. F.) will give considerable toughness at small expense of strength. H. T. Rolfe noted that the cause of this Izod brittleness was quite obscure, but it apparently was confined to alloys which had been somewhat slowly cooled, perhaps at a rate where suf-

ficient ferrite had been allowed to separate from the martensite, forming a maximum amount of troostite. Gray cast iron shows the same phenomenon, but in this case the cause of the change was pearlite.

Unfortunately this steel, largely used for alternately-stressed parts, has a very difficultly determined but probably low proportional limit, so that the widely discordant results give little information of its fatigue strength after slight drawing. Harry Brearley advanced the explanation that low yield stress observations are probably falsified by hardening stresses, released by high reheating temperatures, but not released in the harder specimens until overcome in the tensile test, leaving the hitherto compressed material free to elongate. Such elongation will evidence itself as a plastic movement, but has no relationship to the well-defined "jog" at the yield point shown in stress-strain diagrams of soft steels. Such jogs are absent in nardened nickel: chromium steels annealed either at low temperatures or within the critical ranges.

Sharp changes in direction in the curves at 650 deg. C. (1,200 deg. F.) are due to the uniform practice of cooling the tempered bars in water. This was done to avoid "temper brittleness" liable to arise after slow cooling. In this case the cooling base accentuated the fact that some carbide has passed into solution at the reheating temperature, even though free ferrite is still being disentangled from the sorbite; witness the divergence of the curves for ultimate strength and yield point.

In general Fig. 1 supports the general view that nickel: chromium steels of this general analysis should be tempered at about 600 deg. C. (1,110 deg. F.), and should not be reheated close to the critical range, nor between 250 and 450 deg. C. (480 and 840 deg. F.). On the other hand, for certain obvious uses, tempering at 200 deg. C. is the best possible practice.

Action of Chemical Agents on Concrete.—M. JACOBSON and J. G. DE KERAVENAUT give a description of of the action of chemical agents on concrete, in the November, 1920, issue of *L'Industrie Chimique** of which the following is an abstract.

1. *Action of Acid.* As a general rule concrete is attacked by acids, the lime of the cement giving the corresponding calcium salt. The more concentrated the acid the more vigorous the action. Carbonic acid is not harmful unless the concrete is exposed continuously to large amounts. This last fact will have to be considered especially in the case of fermentation industries.

2. *Action of Acid Compound.* Acid salts such as acid sulphates of sodium, calcium and magnesium act like weak acids. The same applies to acid mineral waters.

3. *Action of Alkalis and Salts.* The alkalis, potash, soda and ammonia are without action, that of alkaline salts is very variable. Thus: Alkaline carbonates accelerate the settling of cement; calcium chloride and sodium chloride have the same action, and this explains why when making concrete the use of salt water or sea sand results in its more rapid settling. Concrete is attacked by magnesium chloride and sulphurous salts.

4. *Action of Tar Derivatives.* Generally tar derivatives are without action on concrete, and a certain member of these derivatives are even used up to 1 to 2 per cent in weight to increase the impermeability of the cement.

5. *Action of Fertilizers.* Lean concrete (small proportions of cement) when freshly laid or low quality cement is attacked by organic fertilizers; but good quality concrete at least one month old is not attacked.

6. *Action of Oils and Fats.* Oils and fats, especially oils of bones, wool, olive, whale and tallow, attack freshly laid concrete, but when the concrete is over a month old it is not attacked. Mineral oils derived from the distillation of coal are without action unless acids are liberated.

*"Action des Agents Chimiques sur les Bétons," *L'Industrie Chimique*, November, 1920, p. 391.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Zinc Sulphide and Oxide. — Pure zinc sulphide is obtained by calcining in a closed vessel a mixture of zinc sulphate, sulphuric acid and sawdust or other carbonaceous material and optionally an alkali or alkaline earth sulphate such as magnesium sulphate. The product is washed with water containing enough sulphuric acid to remove the magnesia and zinc oxide, and barium chloride may be added to the washing water to precipitate barium sulphate with the zinc sulphide. Alternatively pure zinc oxide may be obtained by replacing the zinc sulphate in the original mixture by zinc oxide, or by calcining the mixture in an oxidizing atmosphere, the rest of the process being as described above. (Br. Pat. 148,351, not yet accepted; A. HELBRONNER, Paris, Oct. 20, 1920.)

Synthetic Tanning Agents. — Synthetic tanning agents are prepared (1) by coupling aromatic compounds containing acid groups with vegetable tanning agents, (2) by coupling water-soluble aliphatic compounds with vegetable tanning agents. According to examples: A mixture of phenol sulphonic acid and tannin is heated with formaldehyde solution; a mixture of barium cresol sulphonate and tannin is heated with formaldehyde solution and the product acidified; a mixture of naphthalene sulphonic acid and tannin is heated with formaldehyde solution; a mixture of naphthalene and phenol is heated with sulphuric acid, the product is condensed with formaldehyde, and the resulting tanning agent further heated with tannin and formaldehyde solution; coal-tar phenols of boiling point 185 to 200 deg. C. are heated with sodium sulphite and formaldehyde solution, then quebracho extract and formaldehyde solution are added and the mixture further heated; a mixture of glucose and tannin is heated with formaldehyde solution. The products may be used in tanning alone or mixed with other tanning agents or in combined tanning processes using both vegetable and mineral tanning agents. (Br. Pat. 148,897, not yet accepted; CHEMISCHE FABRIKEN WORMS AKT. GES., Frankfurt-on-Main. See also 148,898, Oct. 27, 1920.)

Cellulose Esters.—The more highly alkylated ethyl, methyl, benzyl and other alkyl esters of carbohydrates of the general formula $(C_6H_{10}O_5)$, such as cellulose, starch, dextrine, lichenine and inuline, are prepared from the lower alkylated esters by further alkylation in the absence of water or in the presence of only

moderate amounts of water. For the further alkylation a large excess of alkali is not required, and a quantity calculated on the amount of alkylating agent present is sufficient; an excess of alkali may, however, be employed, in which case the amount of alkylating agent required is less than that necessary when considerable quantities of water are present. The products obtained are distinguished by their resistance to cold water and by their solubility in a large number of volatile solvents. The lower alkylated esters may first be isolated from the primary alkylating mixtures, as, for example, by precipitation with hot water, alcohol, alcohol ether or acetone; or the further alkylation may be carried out in the primary alkylating mixture after complete or partial removal of the excess of water; and if only a small excess of alkali is to be employed this may be incorporated in the mixture before the water is driven off, provided that care is taken, as by the use of a low temperature, not to damage the esters. The removal of the water may be effected at atmospheric or reduced pressure, with or without heating, and it is facilitated by energetic stirring or kneading; depending on the proportion of water driven off, a paste or powdery mass is obtained. For the further alkylation the finely divided or pasty material is mixed if necessary with an additional quantity of alkali hydroxide, added at once or in small quantities; the alkylating agent is added and the mixture heated, or it is added slowly with heating; the ester is separated by the addition of water, acidified if necessary, collected, washed with dilute acid if necessary and then with water, and dried. Byproducts such as alcohols, ethers, etc., may be distilled off during or after the alkylation, or may be recovered from the alkylating mixture either by steam distillation or by extraction with suitable solvents. In an example the preparation of an ethyl ester of cellulose is described in which a viscose or an alkali- or hydro-cellulose and diethyl sulphate are the primary reacting materials. (Br. Pat. 149,320, not yet accepted; L. LILIENFELD, Vienna, Nov. 3, 1920.)

Japanning.—A process for preserving metals or metal articles from oxidation or rusting, of the kind in which the metal is furnished with a protective adherent film as the result of the application of oil and a high temperature, consists in dipping them in a bath of mineral lubricating oil which may be mixed with a proportion of paraffine oil to render it more fluid and mobile, draining off excess oil, heating them in a chamber or oven at a temperature of about 300 deg. C. until the moist condition is removed and the surface presents a grayish color or matte appearance, then dipping while hot in another bath of oil, such as a mixture of equal parts of whale oil and mineral lubricating oil, and finally cleaning by means of sawdust, etc. The adherent film thus produced acts as an insulator when the articles so treated are employed in electrical contrivances. (Br. Pat. 149,371—1919; N. C. F. JENSEN, Southall, Middlesex, Nov. 3, 1920.)

Alumina.—Alumina is obtained from bauxite or other aluminous material by furnacing the latter in the presence of sulphur dioxide, air and steam, lixiviating the product, and then decomposing the resulting ferruginous solution of aluminum sulphate by means of sodium thiosulphate according to the equation $Al_2(SO_4)_3 + 3Na_2S_2O_3 = Al_2O_3 + 3SO_2 + 3S + 3Na_2SO_4$. The precipitate of alumina and sulphur is calcined to produce pure alumina and sulphur dioxide. In order to make the process cyclic the sulphur dioxide from this source, as well as that evolved according to the equation, may be utilized both for the furnacing operation and for the regeneration of the sodium thiosulphate. The latter is prepared by evaporating to dryness the solution of sodium sulphate which remains after filtering off the alumina and sulphur, reducing the sulphate to sulphide by means of carbon, and then passing air and sulphur dioxide into the aqueous solution of sodium sulphide. If the process is intended to be cyclic the sulphur is separated from the precipitated alumina by distillation or dissolution. To facilitate the furnacing operation the gases may be passed over a catalyst such as ferric oxide; or a catalyst, such as aluminum or other chloride, may be added to the bauxite. (Br. Pat. 149,769—1919; J. MOREL, Grenoble, France, Nov. 10, 1920.)

Separating Incompletely Burnt Coal From Ashes.—Relates to a process for separating coke and incompletely burnt coal from the burnt out residues of boiler ash-pits, furnaces, etc. The non-combustible residues possess magnetic properties due to the presence of certain iron compounds such as pyrites, etc., which are converted into protoxide or sesquioxide or peroxide of iron upon combustion and appear in the ashes as silicates by fusion with silica. Hence by passing these ashes through a highly-concentrated magnetic field, the coal is recovered as a non-magnetic product and separated from the constituents which contain the iron and are retained in the magnetic field. (Br. Pat. 150,333, not yet accepted; F. KRUPP, AKT. GES. GRUSONWERK, Buckau, Magdeburg, Nov. 17, 1920.)

Making Hollow Metal Bars or Tubes.—Hollow metal bars, wires or tubes are formed with one or more holes concentric or eccentric with the external surface of the bar, and each having a smooth and uniform capillary or other bore, by drilling or otherwise forming the initial holes in the billet, and after cleaning, filling them with clean well-fitting mandrels, and forging, rolling or drawing to reduce the size of the hole or holes. The billet and mandrels are then separated by reeling or axial rolling, and the rolling or like processes repeated as often as necessary, the cores or mandrels being coated with a silicate or like inert lubricating material if desired. The smooth clean holes thus formed may be further reduced by drawing. (Br. Pat. 150,562—1919; S. J. MILLS, Cannonfields, Hathersage, Derbyshire, Nov. 17, 1920.)

Welding of Aluminum.—In the electric arc welding of aluminum, an aluminum electrode is used in conjunction with a flux of cryolite. The flux may be applied to the outside of the electrode in paste form, preferably $\frac{1}{32}$ in. thick for a No. 8 S. W. G. electrode, and may be secured by an aluminum wire, thin sheet gauze or a wrapping of cotton or other suitable fabric, or a binder may be incorporated in the paste. The flux may be placed in a hollow electrode of aluminum or in a series of transverse holes therein or in both. Common salt may be added to the cryolite for the more ready application and fixing of the flux and to cause the molten metal to flow more evenly by altering its surface tension. Fifteen per cent of salt may be added before mixing or the cryolite made into a paste with a 10 per cent solution of salt. Salt may be replaced by sodium bisulphate. Aluminum fluoride may be added to the flux to reduce the density when molten. The parts to be welded are preferably pre-heated to a temperature between 300 and 400 deg. C. (Br. Pat. 150,372—1919; F. J. HEYES, Liverpool, Nov. 17, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Informational Service Launched

An Alloys Informational Service, which has been under consideration for a year or more, has been launched by the National Research Council. With an estimated budget of $40,000 for the first year, success of the plan will require the co-operation of 160 subscribers at the rate of $250 per year. However, such a number should readily be enlisted from among the many firms interested in the manufacture or consumption of large quantities of ferrous and non-ferrous metals and alloys.

The service will consist primarily of regular summaries of technical literature from an extensive list of periodicals, domestic and foreign. Concurrently a reference service will produce exhaustive lists of abstracts of previously published information, subjects for these searches to be submitted by members. A complete record of data will be assembled in card-encyclopædia form, and available for reference upon occasion. This encyclopædia will also be the depository of much unpublished material from the subscribers' own laboratories and libraries. In this work emphasis shall be placed upon the physical and chemical properties of pure metals and alloys, the methods of measurement and analysis, alloying methods, and service tests.

Such an organization should have much more than the subscription value to companies intelligently attempting to increase the quality and uses of alloys, to research associations, technical libraries and colleges. It will attempt to co-operate with existing agencies performing such a service in a more limited way, such as the British Institute of Metals, private corporations and various governmental agencies, so as to avoid duplication of effort. The work will be done by men with metallurgical experience and supervised by a competent director.

Further and detailed information may be had by addressing the Division of Research Extension, National Research Council, Washington, D. C.

Meeting of the Syracuse Section of the A. C. S.

The 145th regular meeting of the Syracuse Section of the American Chemical Society was held Dec. 17, 1920, in the Chamber of Commerce Building. Ellwood Hendrick, president of the New York Chemists' Club, presented a paper on "Relativity and Life." Mr. Hendrick pointed out that certain factors have a mutually related, almost functional, influence on human action or condition, and how neglect of this principle makes human life, whether individual or general, both unintelligent and inefficient in its conduct.

Perkin Medal Awarded to W. R. Whitney

At a meeting of the Committee on Award of the Perkin Medal, for the Society of Chemical Industry, held at the Chemists' Club, Dec. 20, Dr. W. R. Whitney, director of the research laboratory of the General Electric Co., was unanimously chosen as the recipient for 1921.

Imports and Exports of Chemicals

Imports of the chemicals on the free list continue to run far ahead of the imports for the corresponding period of last year. The Bureau of Foreign and Domestic Commerce has just assembled the figures for October. They show that the imports of chemicals and drugs on the free list during October, 1920, aggregated $13,437,044. The imports in October of 1919 of chemicals on the free list were half that amount. The average value of the imports of chemicals and drugs during the first ten months of 1920 has been in excess of $18,000,000 monthly.

The imports of coal-tar products in October of 1920 were valued at $2,492,902, which is nearly four times the value of the imports during October, 1919. Imports of gums, during October, 1920, were valued at $5,443,706. This was slightly less than the value of imports in October, 1919. Potash imports in October were valued at nearly $1,000,000, as compared with imports of $77,823 in October, 1919. Imports of some of the chemicals of less importance were as follows:

	Oct., 1919	Oct., 1920
Iodine	$ 55,946	None
Chlorine of lime	544	$7,353
Citrate of lime	131,957	423,862
Magnesite (not purified)	104,743	61,278
Muriate of ammonia	34,903	38,242
Oxalic acid	21,724	69,741

Exports of chemicals are not running far ahead of those of last year and are practically the same as those of 1918. During October, 1920, chemicals to the value of $13,699,452 were exported. This compares with $11,762,469 in October of 1919.

The value of acids exported in October was $479,060, slightly less than the exports of October, 1919. Exports of dyes increased from $1,584,120 to $2,350,448. Extracts for tanning fell from $682,462 in October, 1919, to $201,358 in October of this year. The exports of sodas increased from $1,386,163 to $2,431,556. Sulphur exports increased from $296,192 to $653,858.

Exports of some of the chemicals which move in less volume are as follows:

	Oct., 1919	Oct., 1920
Formaldehyde	$193,212	$41,255
Glycerine	22,626	13,855
Acetate of lime	28,791	74,506
Sulphate of copper	49,497	11,149

Chicago Chemists' Club Entertainment

The annual social event of the Chicago Chemists' Club popularly known as "ladies' night" occurred Thursday evening, Dec. 16. The dinner was followed by dancing and special entertainment, the chief feature of which was an exposé of spiritualism by Mr. Thresher, a member of the psychological staff of Chicago University. He told many pertinent and personal things about the prominent members of the club, later exposing the whole affair as a trick. The increasing popularity of these functions among Chicago chemists was shown in the select group of members and guests attending the party.

Dr. C. E. K. Mees Receives Research Medal

A John Scott medal and premium has been awarded by the Directors of City Trusts of the City of Philadelphia to Dr. C. E. Kenneth Mees, director of the research laboratory of the Eastman Kodak Co., for special researches on the structure of photographic images. This award derives from a bequest of John Scott, a chemist of Edinburgh, who in 1816 left $4,000 to the City of Philadelphia, the interest upon which was to "be laid out in premiums to be distributed among ingenious men and women who make useful inventions." The premiums were originally limited to $200 but by a decision of the Court of Common Pleas of Philadelphia in 1919 the amount was increased to $800 and the "inventions" were held to include any useful to mankind, in chemical, medical, physical or any other science, "or in the development of industry of any form, the test being that the invention is, in the judgment of the trustees, definitely accepted and that it may add to the comfort, welfare and happiness of mankind." An advisory board on the awards was at the same time appointed by the Directors of City Trusts.

The work for which this award has been made is part of the systematic investigation of photographic theory undertaken by the laboratory of which Dr. Mees is director. Since the foundation of the laboratory numerous scientific papers on the structure of photographic images have been published by members of the staff, and the subject as a whole was reviewed by Dr. Mees in a paper recently delivered before the Franklin Institute.

While it covers only one side of the wide field of photographic theory, the study of image structure is of fundamental importance, embracing as it does the question of the sensitive silver compounds which receive the light impression, the sharpness of the images produced, the power to reproduce fine details in photographs and the graininess of the final image.

The recognition by the City of Philadelphia of the work done by Dr. Mees and his colleagues in this field cannot fail to be a stimulus to them and to all scientific men engaged in similar work.

Annual Meeting of American Ceramic Society

The next annual meeting of the American Ceramic Society will be convened at the Hotel Deshler, Columbus, Ohio, Feb. 21 to 24. Arthur S. Watts, professor of ceramics, Ohio State University, is chairman of the local committee in charge of arrangements. Special attention will be given this year to the entertainment of visiting ladies.

The first two evenings of the meeting will be occupied by the smoker and banquet, and on Thursday trips will be taken to Ohio State University and the clay products manufacturing plants which abound in the vicinity of Columbus. The industrial divisions will have separate sessions and the new division on Ceramic Decorative Processes will meet for permanent organization. One of the sessions will be devoted to kilns, saggers and problems of burning.

Trade Conference in Mexico City

The Second United States-Mexico Trade Conference, organized by the American Chamber of Commerce of Mexico, is to be held in Mexico City from April 11 to April 16, 1921. Invitations are to be extended to manufacturers, exporters, importers and all chambers of commerce in order that representatives may be sent to attend the conference.

American Petroleum Institute to Create a Department of Research

At the meeting of the board of directors of the American Petroleum Institute at Washington, D. C., Nov. 19, 1920, a plan was submitted to create a department of research and the following resolutions were adopted:

1. It is the unanimous opinion of the committee that the American Petroleum Institute should create a department of research.
2. That the department of research should for the present confine its energies to compiling, co-ordinating and disseminating the results of research work that is now being engaged in by federal and state bureaus, educational institutions, associations, societies and corporations. To this end the committee unanimously recommended that the director of research of the American Petroleum Institute take the necessary steps to procure the services of:
   a. A development and production engineer to undertake the investigations of oil field problems.
   b. A refinery engineer to make an investigation of the refining problems.
   c. An engineer to investigate the problems relating to the utilization of petroleum and its products.

The committee discussed the qualifications necessary for the appointment of the three engineers, and it was the conclusion of the committee that the director should select such assistants as would have the confidence of the industry and the public, the type of engineers and compensation to be determined largely by the funds available for the development of the division of research.

The committee concurred in the opinion that for the present urgent research problems which confront the industry, company or individuals should be carried on by the proper endowment in some institution having well-equipped laboratories and good facilities.

Paper Co. Establishes Service Bureau

The American Writing Paper Co., Holyoke, Mass., has established a service bureau which is unique in the paper industry. This bureau will co-operate with printers and paper merchants and will aid them in solving their paper problems. In addition, the printers throughout the country have been invited by the company to turn to the director of service for any help, advice or suggestions which will enable them to make their products more attractive and effective. The equipment necessary for the carrying on of the work will be installed later. Joseph A. Borden, formerly general secretary of the United Typothetæ of America, has been appointed director of service by the company.

New Refinery in Texas

The Keen & Woolf Oil Co.'s refinery at Clinton, nine miles below Houston, Tex., on the Ship Channel, has been completed and is now in operation. The plant is said to represent an investment of $750,000 and has a daily capacity of 650 bbl. of crude oil. The plant is manufacturing pale and red lubricating oils, flux, gas oil and fuel oil, utilizing coastal crude, drawn mostly from Goose Creek. The plant has five large stills and power plant and is equipped with the latest machinery. A temporary dock has been built on the Ship Channel for the discharging of oil barges.

Explosion at Monsanto Chemical Co.'s Plant

Three buildings of the Monsanto Chemical Co.'s plant at Second and Lafayette Sts., St. Louis, Mo., were completely demolished and nine persons were injured, two of them seriously, by an explosion which occurred Dec. 15 in Department A-5 of the plant, in which nitrochlorbenzene is manufactured. The cause of the explosion is unexplained, but will be investigated. Officials of the company estimated the damage at $15,000 to the buildings and $35,000 to the stock.

Wrought Pipe Defined

In order to clarify the confusion which exists in the present use of the term wrought-iron pipe, the executive committee and advisory board of the National Pipe and Supplies Association has forcibly called attention to the distinction made by the American Society for Testing Materials in the following resolution:

> Whereas the distributors of pipe for many years used terms to designate the various types and makes of pipe that have not been duly descriptive of same; and
>
> Whereas it is the desire of this association to co-operate in every way with the manufacturers in the development of trade practices and customs of accepted merit, and which will be fair and intelligible to the manufacturers, distributor and public alike; it is hereby
>
> *Resolved*, By the officers and members of the Executive Committee and Advisory Board of the National pipe and Supplies Association in their fall meeting, held in New York City on Thursday, Nov. 11, that it is their judgment that the terms employed by the American Society for Testing Materials in differentiating between iron and steel pipe—namely: (a) welded wrought-iron pipe, (b) welded steel pipe—should be accepted and adhered to by the distributors of both iron and steel pipe, this being in the interest of the manufacturers of the pipe, those who distribute it and those who use it, each being entitled to know clearly and without doubt the make and quality of the pipe involved in the transaction.

This means, if it means anything, that welded pipe is pipe that is welded no matter what it is made of: that welded steel pipe is pipe that is made by welding steel; that welded wrought-iron pipe is pipe that is made of wrought iron by the welding process and that "wrought-iron pipe" is pipe that is made of wrought iron, whatever the process of manufacture.

Measurement and Specification of Color

At the meeting of the Rochester section of the American Chemists and Optical Society of America, held in Rochester, N. Y., Dec. 6, 1920, L. A. Jones, head of the Research Laboratory of the Eastman Kodak Co., presented a paper on "Measurement and Specification of Color."

He said there is a growing demand from the industries for measuring color. This growing need embraces not only the raw materials, but the finished products, and includes such everyday things as paints, varnishes, dyes, textiles, leather and even candy. If this demand continues to grow, the science of colorimetry will be a very important branch of applied optics. A part of the chaotic state of affairs in the measurement of color comes from a lack of color nomenclature. There is no clear-cut definition of color, hue, saturation, etc., and no agreement as to definitions. The terms ashes of roses and elephant's breath are about as definitely as colors are named.

Mr. Jones argued for some logical method of measurement in America. When it is realized there are from 10,000 to 50,000 different colors, the inadequacy of words to describe them is evident. Not only are words to describe color lacking, but also instruments for measuring it. To measure color, light must of necessity be considered. Light is energy radiated in transverse wave lengths, the wave lengths being expressed in millimicrons. The wave lengths lying between 400 and 700 millimicrons, coming to the retina of the eye, give what is called color, the 400-millimicron wave lengths producing violet and the 700 red. By separating light into its component wave lengths and measuring it, a curve for each color could be plotted. This curve would then represent the intensity and relative wave length and would be a physical measurement. But the retina does not separate light into its component wave lengths, receiving mixed radiant energy as a single sensation. There are two phases of this sensation, brightness and color, the latter embracing hue and saturation. Brightness may be defined as the intensity phase of light sensation and color the quality phase of the sensation. To measure color, then, means must be found for measuring hue and saturation. The instrument designed for this purpose is called a colorimeter. By means of it a mixture of monochromatic light of any wave length and white light, the mixture being known and under the control of the operator, can be matched with the color of an unknown. This would then give the wave length hue and the percentage of saturation. By white light is meant the light of the noonday sun on a clear day or its sensation equivalent. Due to weather conditions, it is not often possible to get natural white light, but artificial light can be so altered as to be the same as the noonday sun.

Mr. Jones explained there were two methods of mixing colors, the additive and subtractive. By the additive method the primary colors red, green and blue are mixed in the proper proportion and matched with the unknown, and the analysis stated in percentages of red, green and blue. Most instruments for this purpose are not very satisfactory, due to the difficulty of mixing. By the subtractive method of mixing colors the unknown color to be matched is so manipulated that all colors are subtracted from white light except those components present in the unknown. The Eastman Kodak Co. will soon market a colorimeter employing this principle.

During the war Mr. Jones was a Lieutenant in the United States Naval Reserve and did much valuable work on camouflage as applied to ships. During his lecture he stated that in order to paint ships so they would be invisible through a periscope they must be of the same color as the background—that is, the sky. The artists could not agree as to the color of the sky, so a colorimeter was built, put on a battleship and the color of the sky under varying conditions was measured. The subtractive instrument was found to be the most satisfactory because it did not require motor-driven parts or careful manipulation.

During the general discussion following the lecture Mr. Jones said that inasmuch as the human eye is really half of the colorimeter it is necessary that the operator have a normal eye.

Experiments in Distillation of Oregonian Coals To Be Carried On

Experiments to determine the commercial value of sub-bituminous and lignite coal distributed throughout thirteen counties of Oregon are being conducted by the State Bureau of Mines and Geology. This coal, which has never found a market because of its inferior grade, has been shown in the laboratory to form a good coke on distillation, a fuel gas and a liquid which will be further refined with the idea of extracting gasoline substitute and lubricating oils. The apparatus used in the laboratory of the Oregon Bureau of Mines and Geology has the unique feature that no heat is applied directly to the retort. Instead, an inert gas is passed through heated coils and raised to a temperature of 1,000 deg. F. before being admitted to the retort.

Book Reviews

PRELIMINARY STUDIES FOR H. M. FACTORY, GRETNA, AND STUDY FOR AN INSTALLATION OF PHOSGENE MANUFACTURE. Prepared by Mr. *Quinan* and *William Macnab*, Ministry of Munitions, Department of Explosive Supply, British Government. 145 pp. with numerous diagrams and charts. London, England: His Majesty's Stationery Office; 1920. Price 15s. net.

This excellent work deals with two distinct studies as indicated by the title. The first section covers the details of design and operation of a factory at Gretna to produce 39,000 tons of R.D.B. cordite per annum, comprising a cotton waste plant, nitrating house, acid-mixing and storage equipment, beating and poaching building, pulping house, nitroglycerine plant, cordite plant, air-compressor plant, nitric acid plant, power house, etc. The second section embraces in like detail a proposed installation for manufacturing phosgene from CO, derived from coke burned in gas producers, and dry chlorine, and a second method using CO from coke burned in pure oxygen, catalyzers being employed for the combination of the two gases in both instances.

The text sets forth the studies and calculations which formed the basis of design and construction. The whole is an example of an admirable way of treating and presenting engineering matter. Many of the details are of first interest to chemical engineers. American engineers visiting London have been deeply impressed with the systematic procedure developed by Mr. Quinan and the completeness of his technical reports.

CHESTER H. JONES.

* * *

INDUSTRIAL CHEMISTRY. Edited by *Allen Rogers*, in charge of industrial chemistry, Pratt Institute, Brooklyn, N. Y. 3rd edition, revised and enlarged. 1,255 pp.; 377 illustrations. New York: D. Van Nostrand Co., 1920. Price, $7.50.

The two earlier editions have made Dr. Rogers' work so well known and so widely recognized as the best single volume presentation of American practice in industrial chemistry that it seems hardly necessary to more than mention that a revised and enlarged edition is now available. Since a critical review would require the collaboration of specialists in the wide range of industries covered by the book, the present discussion will be limited to the more striking features of the revision.

It is only natural that the first question should be, "What about new material?" Four new chapters will be found, as follows: Turpentine and Rosin, by Dr. Charles H. Herty; Practical Applications of Colloid Chemical Principles, by Dr. Jerome Alexander; Dehydrated, Dried and Evaporated Foods, Condensed Foods, by Clarence V. Ekroth; Baking, by Arnold Wahl.

In addition, about 160 pages of new material is distributed among the other chapters. In spite of the increase in the number of pages, the use of thinner paper and a flexible binding makes the book more convenient to handle than the second edition. The mechanical preparation of the book is good, the few typographical errors noted being, with one or two exceptions, of only minor importance.

Owing to the death of Robert B. Dole, revision of the chapter on Water for Industrial Purposes was made by H. Stabler and A. A. Chambers. The method of calculating coefficients of foaming, corrosion and scale hardness from a water analysis is given in detail. Processes for purification and softening of water are thoroughly summarized.

The chapter on general processes has been greatly improved by the inclusion of a greater variety of presses, driers, evaporators and stills. The old section on chemical engineering materials has been replaced by a description of recent apparatus used particularly in the coal-tar intermediate and dye industry and of various types of hydraulic presses.

It is well to bear in mind that none of the industries can be exhaustively treated in the space allotted and that the real function of the book is rather to give a broad view of the interrelations which exist in the field of industrial chemistry. Dr. Rogers and his staff are to be congratulated upon the successful accomplishment of such a difficult task.

ALAN G. WIKOFF.

Personal

L. P. ALFORD, formerly editor of *Industrial Management*, will be editor of *Management Engineering*, a new publication to be published by the Ronald Press, 20 Vesey St., New York City.

L. T. BRYSON is now engaged in analytical research work for the Dearborn Chemical Co., Chicago, Ill.

E. B. CLARK, formerly with the laboratories of the Ward Baking Co. and Hecker-Jones-Jewell Milling Co. of New York City, has resigned as chief chemist for the Omaha (Neb.) Flour Mills Co. and accepted the position of manager of the Royal Baking Co., Oklahoma City, Okla.

H. H. CLAUDET, who for some years past has been in charge of the Ottawa branch of the General Engineering Co., Salt Lake City, will, on Jan. 1, 1921, take over the office and laboratory and conduct an independent business as a consulting chemical engineer.

Dr. EUGENE HAANEL, director of the Mines Branch, Ottawa, Canada, since 1907, when the department was first constituted, has retired in compliance with the regulations of the superannuation act. Previous to his appointment as director Dr. Haanel was superintendent of mines in the Department of the Interior from 1901 to 1907.

ELLWOOD HENDRICK, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, addressed the meeting of the Syracuse Section of the American Chemical Society, Dec. 17, on "Relativity and Life." On Dec. 21 he made the address before the Rhode Island Section, at Brown University, on "Chemistry for Everyman."

GEORGE GUESS, professor of metallurgy, University of Toronto, Canada, has been chosen chairman of the Toronto Branch of the Canadian Institute of Mining and Metallurgy for the coming year.

SAMUEL PAGE, professor of chemistry, Canterbury College, Christ Church, New Zealand, has just completed an extensive tour of the chemical industries in the United States. He will return to New Zealand in January.

FREDERICK POPE, of Moses, Pope & Trainor, Inc., New York City, has returned from a two months' business trip in Europe.

GERALD R. SIMPSON has resigned his position as superintendent of the Standard Minerals Co., Kingman, Ariz., to engage in the manufacture of a pneumatic flotation machine of his invention.

Obituary

SANFORD H. STEELE, general counsel and former president of the General Chemical Co., died at Pinehurst, N. C., on Sunday, Dec. 19, of pneumonia after only a few days' illness. Mr. Steele was by ancestry and training a New Englander, although he was born over the border at Stanstead, Canada, on Nov. 26, 1847. He was graduated from Dartmouth College in 1870 and studied law in the office of his brother, Benjamin H. Steele, who was a Justice of the Supreme Court of the State of Vermont. He eventually withdrew from general legal practice and became associated with the General Chemical Co., to which he had devoted his entire attention for many years.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Dec. 27, 1920.

The chemical market has shown signs of irregular activity during the last few months and in most instances the call for additional lots was very quiet. During September and October large offerings of surplus material reached the market for consumers through second hands and these had a depressing influence on quotations. Liquidation was in evidence at intervals and where price changes occurred the fluctuation was downward. During the latter part of November selling pressure decreased to some extent and a steadier tone developed. Current reports stated that a quiet absorption of stocks had placed the general market in a stronger position, although it was admitted that the consuming demand was not active enough to restore permanency to the entire list.

Manufacturers' prices remained fairly steady, and the most violent fluctuations were confined to speculative items where original buyers had been nipped with high-priced goods and were desirous of selling in the open market regardless of costs. During December it became apparent that the downward trend had run its course in some of the items, as moderate buying orders found the market in exceedingly scant supply and it looked as though the enforcement of real buying would meet with a ready response in prices. The absence of important activity, however, kept trade sentiment rather pessimistic and large dealers complained continually about slow business. Export orders were limited to small lots and specialties only and the movement in this direction was quiet and devoid of particular feature. Exporters on many occasions received large cancellations and some offered these holdings at price concessions rather than put them in storage indefinitely and incur additional expense.

Leading Interests Optimistic

Leading interests close to the pulse of trade seemed more hopeful at the turn of the year than in the last six months. Reports emanating from many textile points announcing a reduction in wages and also that operations would open full at the beginning of the year were encouraging. Enormous purchases of fats and oils by some of the most prominent soapmakers created an impression that these interests would shortly need quantities of miscellaneous chemicals. Recent inquiries on bichromate of soda indicated that stocks among tanneries were at least reduced. Paper prices have not declined in proportion to other commodities and it looked as if the paper mills were still experiencing a good demand. It is understood that the inquiry for bleaching powder, sulphur and other chemicals needed in the manufacture of paper was improving.

The Paint Situation

The sensational drop in linseed oil, turpentine and rosin has allowed paint factories to produce at a lower cost than at any time in many months. With enormous building operations under way, it seems reasonable that the paint makers are in for a busy season when the holiday period is over. Any improvement in the demand for these products will surely be reflected in the market, for such chemicals are used by all paint factories. The consensus is that the chemical market has seen its lowest point. Any abnormal resumption of buying activity is not looked for at the beginning of the new year, but there is no doubt that with new legislative measures there will be a gradual and steady improvement during the first quarter.

Chemical Prices

The leading manufacturers of *caustic soda* and *soda ash* have maintained their contract prices with regularity. Consumers have bought solid caustic for delivery over next year at 3¾c. per lb., basis 60 per cent works. Light soda ash has been taken in single bags at prices ranging from $1.82½ to $1.90 per 100 lb. in carlots, basis 48 per cent f.o.b. works. Consuming inquiry showed a moderate improvement for these chemicals and some of the largest producers stated that orders placed compared favorably with those in pre-war periods at this time of the year. The fact that resale caustic soda and soda ash were offered in the open market below the contract prices has probably held back future buying. Producers announce that they have adjusted contract prices to a basis which is reasonable under the increased cost of production and they asserted that there will be no further reduction in values unless the price of fuel and labor are reduced proportionately.

Manufacturers of *bleaching powder* have held the contract market at 3½c. per lb. works for large drums and have booked considerable business with paper mills. Resale bleach reached the market during November in heavy volume and prices declined from 6c. per lb. to 3¼c. per lb. for spot material. Large makers of *copper sulphate* have been able to offer their product at a more attractive price on account of the decline in copper metal. Some inquiries have reached the market from agricultural interests and business has been placed earlier than usual among insecticide manufacturers. *Bichromate of soda* producers have not quoted openly under 15c. per lb. for delivery over 1921, but dealers in their competition for new business forced the spot market from 11c. per lb. in November to 9½c. for spot goods. *Carbonate of potash* declined severely under keen competition instituted by prominent sellers, and spot prices were heard as low as 12c. per lb. for the 80-85 per cent grade. The price during January, 1920, was as high as 23c. per lb. for this material. *Prussiate of soda* declined from 22c. per lb. in November to 12½c. for stocks in the warehouse. Manufacturers quoted the contract price at 22c. and stated that a fair volume of business with the regular consuming trade was booked at this level.

Coal-Tar Products

The tone of the coal-tar products market appeared more stable after election and the trade seemed more hopeful. During the last few months the markets showed little prospect of brightening up and sales were meager. In most cases buyers covered only their needs for very short periods. There seemed to be a volume of second-hand material on the market, available at very low prices, and producers have been anxiously waiting for this surplus stock to be absorbed. As a result the market has receded to its lowest ebb.

The crude market has been a mixed affair, with some issues holding steady while others show weakness, while concessions on firm bids were noted. Producers reduced prices *on benzene, toluene, solvent naphtha* and *xylene* about 2c. per gal., but even this reduction produced no change in the volume of business. *Anthracene* showed some signs of weakness owing to recent importations from England and a lack of demand from usual quarters. The *naphthalene* situation continued to show quantities available and a regular supply of material coming in from Europe.

The following is a list of coal-tar products, giving the high and low prices during the past few months:

Benzene, C. P. per lb.	$0.37	$0.32
Cresylic acid, 97-99 per cent, per gal.	1.15	.95
Napthalene flakes, per lb.	.15	.09
Phenol, per lb.	.17	.09
Solvent naphtha, water white, per gal.	.32	.30
Toluene, C. P., per gal.	.37	.35
Benzoic acid, per lb.	.85	.75
H acid, per lb.	1.85	1.40
Salicylic acid, per lb.	.45	.35
Alphnaphthalamine, per lb.	.55	.40
Aniline oil, per lb	.30	.22
Aniline salt, per lb.	.35	.27
Benzidine base, per lb.	1.25	1.00
Beta naphthol, per lb.	.65	.40
Diethylaniline, per lb.	1.55	1.45
Dimethylaniline, per lb.	1.05	.65
Diphenylamine, per lb.	.85	.77
Nitrobenzene, per lb.	.15	.15
Orthotoluidine, per lb.	.35	.30
Para amidophenol, base, per lb.	2.75	2.20
Paranitraniline, per lb.	1.20	.90
Paratoluidine, per lb.	1.85	1.70
Resorcinol, technical, per lb.	2.85	2.80

Next week we shall publish a comparison of prices of leading general chemicals over 1920 to date.

The Chicago Market

Chicago, Dec. 21, 1920.

A spotty market is the rule today, with the soft spots most plentiful. Normally, sales are at a minimum at this time of year, and this condition is accentuated by the cessation of routine buying.

Much interest is expressed on all sides in regard to pending tariff legislation in the Congress and sellers are not anxious to make and sell goods under present conditions when they may be granted additional protection in a short time. The organization of the Foreign Trade Financing Corporation is also being watched with some hope that its activity may stimulate export business in naval stores and oils. The almost absolute lack of buying interest tends to render quotations valueless, as there is frequently a 25 per cent range between the quoted price and the figure at which sales are consummated.

Heavy Chemicals

Blue vitriol and *salt cake* are the two bright spots in the line just now. Copper reductions have allowed favorable quotations to be made on the sulphate and consumers are taking advantage of the situation. Transactions passed at prices ranging upwards from $6 to $7 per 100 lb. on 99 per cent domestic, the higher price representing today's market. Overstocks of salt cake being exhausted, users are compelled to pay $35@$40 per ton f.o.b. point of production. Consuming interests maintain a steady demand.

Alkalis remain weak, neither limited supply nor low prices having any effect to stimulate demand. *Caustic soda* is offered at $3.75@$4 per 100 lb. *Sodium bichromate* alone shows strength, price remaining firm at around 12c. per lb. *Formaldehyde* at 20@21c. is moving slowly. 95 per cent *ethyl alcohol* is quoted at $5.50@$5.90 per gal. and *denatured* at 90@92c. per gal. On account of light trading *glycerine* prices are to be considered as nominal, both holders and consumers awaiting developments. C.P. grade is offered at 17½@18c. f.o.b. factory in car lots. Dynamite grade is 2c. lower. *Lead acetate* is off to 15½c. per lb. for white granular variety.

Among the acids there is but little business and what there is is tending to work to lower levels. 66 deg. *sulphuric* is quoted on today's market at 21.50@$22 per ton in tanks, with but few transactions recorded. *Nitric*, 36 deg., is 6¾c. per lb. and *oxalic* has declined under weak demand to 19@21c. *Citric* is in fairly limited supply, second hands asking 52c. for crystals. Makers' price is 54c. *Acetic* is easy at 12c. for glacial, 99 per cent.

Coal-Tar Products

The holiday season has accentuated previous dullness in this line and business is practically suspended for the time being. Market prices are unchanged but are purely nominal, dealers and manufacturers alike being ready to shade if real business is in sight. *Benzene*, pure, is holding fairly firm at 33½c. per gal., and *toluene* is held at 35c. in drums. *Naphthalene* continues in plentiful supply and current quotation of 9c. per lb. on flakes and 10c. on balls would be lowered if business were in sight. *Aniline salt*, with no demand, ranges in quotation from 28c. to 35c. per lb. *Aniline oil*, in a similar position, is priced 20c.@28c. per lb. There are plentiful supplies of both.

Naval Stores—Vegetable Oils

In common with other lines, naval stores are stagnant during the holiday season. Producers seem to be in for a loss on this fall's production as labor costs in the producing field were high during the season just closed. The present return of Southern labor to practically a pre-war wage basis has the effect of causing consumers to expect lower prices on pine products. Cost on present stock being high, producers are reluctant to cut and lack of trading is the result. No recent price changes of moment have occurred. Today's price on *turpentine* in cooperage, car lots f.o.b. Chicago, is 95c. per gal. Steam distilled *pine oil*, .933 pure, is holding firm at $1.70, price fluctuation being prevented by the existence of heavy buying contracts. The destructively distilled variety is quoted at $1.35.

It is reported that Oriental producers have re-entered the selling field, having been forced by financial stringency to liquidate stocks hitherto held for high figures. If this is true to any great extent a recession of price to somewhere near the pre-war level may be expected. *Soya bean oil* is now offered at 5½@5¾c. in sellers' tanks f.o.b. coast, but if the three million pound shipment now reported as afloat arrives soon the price will undoubtedly break. Prime summer yellow *cottonseed oil* is quoted at 7½c. per lb. f.o.b. Chicago, with no takers. There is some trading in refined, deodorized at 12@13c. *Corn oil*, for which 7@8c. per lb. was asked a few days ago, is now offered at 6¾c. c.a.f.

The St. Louis Market

St. Louis, Dec. 22, 1920.

The heavy chemical market shows no change from the dullness that has marked it recently. Conditions seemingly have settled into a *status quo* for the time being. Prices of several articles in bulk lots have declined slightly, but producers still maintain their control of the situation and no recession of a general nature has taken place or is expected.

Spot business has not improved in the last two weeks to any extent, but contracts continue to be closed in satisfactory numbers and producers estimate that the major portion of their 1921 production is contracted for. On account of the decline in spot business, however, production is being slightly curtailed at present. The heavy chemical industry here, though, is fortunate in having as consumers of its products the glass, oil-refining, paper and wood pulp and wood-preserving industries, all of which continue to operate to capacity. For this reason heavy chemical producers expect their contract business to tide them over the depression in spot business.

The oil refineries continue to demand large quantities of the 66 deg. *sulphuric acid*, and this market is keeping producers fairly busy. Quotations on bulk lots have declined to $20@$21 per ton from $22, but the carboy price remains at 1¾c. per lb., carload lots. The 98 deg. sulphuric acid is not in strong demand but quotations are firm at $25 per ton f.o.b. works. There is little call for the 60 deg. sulphuric acid and quotations have declined to $16, against $16.50 per ton two weeks ago. The carboy price is being maintained at 1½c. per lb. The oleum market is dull with a nominal quotation of $28.50 per ton.

Demand remains quiet for *muriatic acid*, but not a great deal is being offered and producers are holding prices at their former levels of 1¾@2c. per lb. and $25 per ton in bulk.

Sodium bisulphate continues to show flashes of activity. Producers have allowed their supplies to become smaller but have sufficient to take care of the demand. The current quotation is $7@$8 per ton.

Practically no change is noticeable in the *nitric acid* market. Spot demand is dull, but contract deliveries are fairly satisfactory. Quotations are $7 per 100 lb. for the 36 deg. test and $10 per 100 lb. for the 42 deg. test. Standard mixed acid is quoted at 1½c. per lb. of sulphuric content and 11½c. per lb. per unit of nitric acid.

Demand for *zinc chloride* is spotty and quotations have dropped to $4.15 per 100 lb., against $4.50 per 100 lb. previously.

The Iron and Steel Market

Pittsburgh, Pa., Dec. 24, 1920.

The markets in finished steel products are quite steady at the Industrial Board or Steel Corporation prices, to which most of the independents recently reduced their official quotations. Pipe is an exception, as the independent list remains, being $7 to $10 a ton above the corporation level. In some quarters it is now predicted that independents will issue new lists, dated Jan. 1, on the Industrial Board basis. This would be an earlier date than was recently predicted, as pipe had shown exceptional strength. Even now the shipments are very heavy.

The finished steel markets have not, however, been seriously tested. Very little business has been offered, as buyers in general are in mood to wait until after Jan. 1

for taking action even on very near-by requirements. The trade has formed some ideas as to shading by independents, something that was predicted as likely to occur soon after the independents reduced their quotations to the Steel Corporation level. Some independents are picked out as being quite unlikely to shade prices in the near future, but to content themselves with idleness instead. Others, particularly some of the smaller interests, are regarded as likely to cut prices on the first appearance of interesting inquiries.

Operations

The Steel Corporation continues to operate at over 90 per cent of capacity, on the ingot basis. On the whole its shipments are somewhat in excess of production, as it is steadily moving a large quantity of pipe accumulated during the car shortage, its shipments to customers being about 50,000 tons daily, against a rated capacity of approximately 52,500 tons daily.

As to the independents, their operating rate is very low, probably under 35 per cent on an average in the past few days, but at this time the actual rate of operation is not an altogether safe criterion, for the reason that the last week or two of the year furnishes a particularly attractive time for closing, if there is to be any closing at all. Inventory taking is facilitated, and stocks of partly finished material can be cleaned up by closing certain departments and allowing the others to catch up. A few mills idle in the past week have probably been so as part of a holiday program, while a great many will close tonight with the expectation of resuming Jan. 3.

Considering the volume of shipments being made of late, their ready receipt by buyers and the disposition of buyers to reduce stocks to the minimum, it appears that the rate of actual steel consumption at the present time is quite large, representing less decrease from the rate during the recent very active period than might be expected.

Prices

Bars are quotable at 2.35c., shapes at 2.45c., and plates at 2.65c. There has been a little shading in these lines, but chiefly by way of Western consumers conceding a part of their freight advantage, so that the shading would only be of the Pittsburgh basis. In sheets prices have been steady at 3.55c. for blue annealed, 4.35c. for black and 5.70c. for galvanized. Quite an exceptional inquiry is out, for 16,000 tons of various descriptions of sheets, very attractive specifications, for delivery over the first six months of the new year. If there is to be shading in sheets, this inquiry seems certain to develop the fact.

Strip prices have again been reduced, to 3.30c. for hot-rolled and 6.25c. for cold-rolled. The 3.30c. price is analyzed as the Industrial Board price of 3.05c. for hoops, plus a standard extra of 25c. per hundred pounds for strip finish. Contracts have been adjusted to the reduced basis, and this has brought forth some releases. New buying in strips is absent, but a fair volume of business is expected in January.

Pig Iron

The pig iron market remains stagnant. Prices are merely nominal, at $35 for bessemer and foundry and $33 for basic f.o.b. valley furnaces, freight to Pittsburgh being $1.96. It seems very probable that about Jan. 1 there will be a further decline, possibly to $30 for basic iron, a figure that the furnaces seem to think would have a chance of being maintained for a time.

Coke

While most of the furnaces have been indisposed to contract for Connellsville furnace coke for the first half of the new year, an exception was noted in last report, contracts having been closed for a total of a trifle over 40,000 tons a month, at a ratio of 5 to 1 against basic pig iron at valley furnaces. Additional business of this sort is now to be reported, another coke producer having taken part, and the total to date is fully 75,000 tons a month. Several weeks ago some contracts were made on a ratio basis of 4½ to 1. These contracts are practically on the shelf, as they are requirement contracts and the furnaces involved are already out of blast.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.55 – $0.60
Acetone	lb.	$0.13 – $0.13½	.13½ – .14
Acid, acetic, 28 per cent	100 lbs.	3.00 – 3.25	3.50 – 3.75
Acetic, 56 per cent	100 lbs.	7.25 – 7.50	7.75 – 8.00
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.50 – 11.00	11.25 – 11.50
Boric, crystals	lb.	.14½ – .15	.15½ – .16
Boric, powder	lb.	.15½ – .16½	.17 – .18
Citric	lb.	–	.52 – .54
Hydrochloric (nominal)	100 lb.	1.85 – 2.25	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.07 – .07½	.08 – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.18 – .18½	.19 – .20
Phosphoric, Ortho, 50 per cent solution	lb.	.18 – .18½	.18½ – .19
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	–	–
Sulphuric, 60 deg., drums	ton	–	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 19.00	–
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 – 24.00	–
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P.	lb.	–	1.30 – 1.35
Tannic (tech.)	lb.	.50 – .55	.56 – .60
Tartaric, crystals	lb.	–	.42 – .44
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	–	5.50 – 6.00
Alcohol, Methyl (see methanol)		–	–
Alcohol, denat red, 188 proof (nominal)	gal.	–	.82 – .84
Alcohol, denatured, 190 proof (nominal)	gal.	–	.88 – .90
Alum, ammonia lump	lb.	.04½ – .04¾	.05 – .05½
Alum, potash lump	lb.	.05½ – .06	.06½ – .07
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb.	.02½ – .03	.03½ – .03½
Aluminum sulphate, iron free	lb.	.03½ – .03¾	.04 – .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06¾ – .07	.07½ – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.33 – .35	.36 – .38
Ammonium carbonate, powder	lb.	.14 – .14½	.14½ – .15
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	.10½ – .11	.11¼ – .11½
Ammonium chloride, granular (gray salammoniac)	lb.	.10 – .10½	.10½ – .11
Ammonium nitrate	lb.	.09 – .09½	.10 – .10½
Ammonium sulphate	lb.	.03¾ – .04	.04 – .04½
Amylacetate	gal.	–	4.50 – 5.00
Amylacetate tech	gal.	–	4.00 – 4.20
Arsenic oxide, lumps (white arsenic)	lb.	.11½ – .12	.12½ – .12½
Arsenic, sulphide, powdered (red arsenic)	lb.	.15 – .15½	.15 – .16
Barium chloride	ton	75.00 – 80.00	85.00 – 90.00
Barium dioxide (peroxide)	lb.	.24 – .25	.26 – .27
Barium nitrate	lb.	.11 – .11½	.12 – .13
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calc. hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.50 – .52	.54 – .56
Calcium acetate	100 lbs.	2.00 – 2.25	–
Calcium carbide	lb.	.04 – .04½	.04 – .05
Calcium chloride, fused, lump	ton	30.00 – 32.00	33.00 – 35.00
Calcium chloride, granulated	lb.	.02 – .02½	.02½ – .03
Calcium hypochlorite (bleach'g powder)	lb.	.03 – .03½	.03½ – .04
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 – .80
Calcium sulphate, pure	lb.	–	.25 – .30
Camphor	lb.	–	.90 – .95
Carbon bisulphide	lb.	.08 – .08½	.09 – .09½
Carbon tetrachloride, drums	lb.	.12 – .12½	.13 – .13½
Carbonyl chloride (phosgene)	lb.	–	.60 – .75
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	–	.43 – .50
Cobalt oxide	lb.	–	3.90 – 4.00
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.22 – .22½	.24 – .25
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.06½ – .06¾	.07 – .07½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Ethyl Acetate Com. 85%	gal.	–	1.05 – 1.10
Ethyl Acetate pure (acetic ether 98% to 100%)		–	–
Formaldehyde, 40 per cent (nominal)	lb.	.18½ – .18¾	.19 – .19½
Fusel oil, ref	gal.	–	3.60 – 3.75
Fusel oil, crude (nominal)	gal.	–	3.00 – 3.25
Glauber's salt (see sodium sulphate)		–	–
Glycerine, C. P. drums extra	lb.	–	.20 – .21
Iodine, resublimed	lb.	–	3.85 – 4.00
Iron oxide, red	lb.	–	.15 – .25
Iron sulphate (copperas)	100 lb.	1.50 – 1.75	2.00 – 2.25
Lead acetate, normal	lb.	–	.13½ – .16
Lead arsenate (paste)	lb.	.13 – .14	.14½ – .15
Lead nitrate, crystals	lb.	–	.90 – 1.00
Litharge	lb.	.12 – .12½	.13 – .13½
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	.10½ – .11	.11½ – .12
Magnesium sulphate, U. S. P.	100 lb.	3.00 – 3.25	–
Magnesium sulphate, commercial	100 lb.	–	1.50 – 1.75
Methanol, 95%	gal.	–	1.75 – 1.80
Methanol, pure	gal.	–	2.10 – 2.15
Nickel salt, double	lb.	–	.12 – .12½
Nickel salt, single	lb.	–	.13 – .13½
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.50 – .52	.53 – .55
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.17½ – .17¾	.18 – .18½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ – $	$0.38–$0.40
Potassium bromide, granular	lb.	–	.43 – .50
Potassium carbonate, U. S. P.	lb.	.50 – .55	.56 – .60
Potassium carbonate, crude	lb.	.12 – .12½	.13 – .13½
Potassium chlorate, crystals	lb.	.12 – .13	.13½ – .18
Potassium cyanide	lb.	–	.65 – .70
Potassium hydroxide (caustic potash)	lb.	.14 – .14½	.15 – .16
Potassium muriate	ton	95.00 – 100.00	–
Potassium iodide	lb.	–	3.00 – 3.20
Potassium nitrate	lb.	.11½ – .12	.12½ – .13
Potassium permanganate	lb.	.60 – .63	.65 – .70
Potassium prussiate, red	lb.	.55 – .57	.58 – .60
Potassium prussiate, yellow	lb.	.33 – .33½	.33 – .34
Potassium sulphate (powdered)	ton	$240.00 – 255.00	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	–	45.00 – 50.00
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.43 – .45
Soda ash, light	100 lb.	1.90 – 2.00	2.10 – 2.30
Soda ash, dense	100 lb.	2.30 – 2.50	2.75 – 3.00
Sodium acetate	lb.	.06½ – .07	.07 – .07½
Sodium bicarbonate	100 lb.	2.45 – 2.60	2.65 – 3.00
Sodium bichromate	lb.	.09½ – .10	.10 – .10½
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ – .07	.07½ – .08
Sodium borate (borax)	lb.	.07½ – .08	.08¼ – .08½
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium chlorate	lb.	.10 – .10½	.10½ – .11
Sodium cyanide, 96-98 per cent	lb.	.22 – .24	.26 – .29
Sodium fluoride	lb.	.17 – .17½	.17½ – .18½
Sodium hydroxide (caustic soda)	100 lb.	3.75 – 4.00	4.25 – 4.35
Sodium hyposulphite	lb.	–	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	2.85 –	3.00 –
Sodium nitrite	lb.	.06 – .06½	.06½ – .07
Sodium peroxide, powdered	lb.	.30 – .31	.32 – .34
Sodium phosphate, dibasic	lb.	.03¾ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.33 – .35
Sodium prussiate, yellow	lb.	.17½ – .17	.18 – .18½
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01¾	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.03 – .03½	.03½ – .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.25 – 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	.06 – .06½	.07 – .07½
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.20 – .20½	.21 – .22
Sulphur chloride, red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	16.00 – 20.00	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	–	3.70 – 4.35
Sulphur, roll (brimstone)	100 lb.	–	3.40 – 3.90
Tin bichloride, 50 per cent	lb.	.18 – .19	–
Tin oxide	lb.	–	.50 – .51
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.12 – .13	.13½ – .14
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.10 – .10½	.11 – .11½
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.40 — .44
Aniline oil, drums extra	lb.	.22 — .26
Aniline salts	lb.	.27 — .30
Anthracene, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.00 — 1.10
Benzidine sulphate	lb	.85 — .90
Benzoic acid, U.S.P.	lb.	.75 — .80
Benzoate of soda, U.S.P.	lb.	.75 — .85
Benzene, pure, water-white, in drums (100 gal.)	gal.	.32 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.30 — .32
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta-naphthol benzoate (nominal)	lb.	3.50 — 4.00
Beta-naphthol, sublimed (nominal)	lb.	.75 — .80
Beta-naphthol, tech (nominal)	lb.	.40 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97–99%, straw color, in drums	gal.	.95 — 1.00
Cresylic acid, 95-97%, dark, in drums	gal.	.90 — .95
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzene	lb.	.07 — .10
Diethylaniline	lb.	1.45 — 1.50
Dimethylaniline	lb.	.65 — .90
Dinitrobenzene	lb.	.30 — .37
Dinitroclorbenzene	lb.	.27 — .32
Dinitronaphthalene	lb.	.42 — .45
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.30 — .32
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.75 — .77
H-acid (nominal)	lb.	1.40 — 1.55
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.17 — .18
Monoethylaniline	lb.	1.75 — 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.09 — .09½
Naphthalene, flake	lb.	.09 — .09½
Naphthalene, balls	lb.	.09½ — .10
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.40 — .50
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.25 — .40
Ortho-toluidine	lb.	.30 — .32
Para-amidophenol, base	lb.	2.10 — 2.20
Para-amidophenol, HCl	lb.	2.25 — 2.40
Para-dichlorbenzene	lb.	.10 — .15
Paranitroaniline	lb.	.93 — 1.00
Para-nitrotoluene	lb.	1.25 — 1.40
Para-phenylenediamine	lb.	2.20 — 2.35
Para-toluidine	lb.	1.70 — 1.80
Phthalic anhydride	lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.09 — .10
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	2.80 — 2.90
Resorcinol, pure	lb.	3.60 — 3.80
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.32 — .33
Salicylic acid, U. S. P.	lb.	.35 — .37
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30 — .35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .22
Sulphanilic acid, crude	lb.	.32 — .35
Tolidine	lb.	1.40 — 1.45
Toluidine, mixed	lb.	.45 — .55
Toluene, in tank cars	gal.	.30 — .32
Toluene, in drums	gal.	.33 — .35
Xylidines, drums, 100 gal.	lb.	.45 — .50
Xylene, pure, in drums	gal.	.45 — .47
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.37 — .38
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.26 — $0.27
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.35 — .40
Carnauba, No. 1 (nominal)	lb.	.80 — .90
Carnauba, No. 2, North Country	lb.	.70 — .80
Carnauba, No. 3, North Country	lb.	.25 — .26
Japan	lb.	.19 — .20
Montan, crude	lb.	.12 — .14
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.07½ — .08
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.07½ — .07¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.09 — .09½
Paraffine waxes, refined, 125 m.p.	lb.	.09½ — .09¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.10½ — .11
Paraffine waxes, refined, 133-135 m.p.	lb.	.13½ — .14½
Paraffine waxes, refined, 135-137 m.p.	lb.	.14½ — .15½
Stearic acid, single pressed	lb.	.17½ — .17¾
Stearic acid, double pressed	lb.	.18½ — .19
Stearic acid, triple pressed	lb.	.22½ — .23

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.90
Pine oil, pure, dest. dist.	gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	$8.75	— .....
Rosin E-I	280 lb.	8.75	— .....
Rosin K-N	280 lb.	8.75	— .....
Rosin W. G.-W. W.	280 lb.	9.00	— .....
Wood rosin, bbl.	280 lb.	9.00	— .....
Spirits of turpentine	gal.	.78	— .....
Wood turpentine steam dist	gal.	.76	— .....
Wood turpentine, dest. dist.	gal.	.76	— .....
Pine tar pitch, bbl.	200 lb.	.....	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	— 15.00
Retort tar, bbl.	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.60	— .....
Rosin oil, second run	gal.	.62	— .....
Rosin oil, third run	gal.	.75	— .....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine (nominal)	lb.	$0.21	— $0.21½
Upriver coarse (nominal)	lb.	.14½	— .15
Upriver caucho ball (nominal)	lb.	.15	— .15½
Plantation—First latex crepe	lb.	.17	— .....
Ribbed smoked sheets	lb.	.16½	— .....
Brown crepe, thin, clean	lb.	.16	— .....
Amber crepe No. 1	lb.	.17	— .....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.13½	— $0.14
Castor oil, AA, in bbls.	lb.	.14½	— .15
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.09½	— .10¼
Cocoanut oil, Ceylon grade, in bbls.	lb.	.13	— .13½
Cocoanut oil, Cochin grade, in bbls. (nominal)	lb.	.13½	— .14
Corn oil, crude, in bbls.	lb.	.09½	— .10
Cottonseed oil, crude (f. o. b. mill)	lb.	.06	— .07
Cottonseed oil, summer yellow	lb.	.09½	— .09¾
Cottonseed oil, winter yellow	lb.	.10½	— .11
Linseed oil, raw, car lots (domestic)	gal.	.81	— .82
Linseed oil, raw, tank cars (domestic)	gal.	.75	— .77
Linseed oil, boiled, car lots (domestic)	gal.	.83	— .84

Olive oil, commercial	gal.	2.75 —	3.00
Palm, Lagos	lb.	.08½ —	.09
Palm, Niger	lb.	.07½ —	.08¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½ —	.09
Peanut oil, refined, in bbls	lb.	.14¼ —	.14½
Rapeseed oil, refined in bbls	gal.	1.15 —	1.20
Rapeseed oil, blown, in bbls	gal.	1.25 —	1.35
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09½ —	.10
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.06 —	.07
FISH			
Light pressed Menhaden	gal.	$0.65 —	$0.70
Yellow bleached Menhaden	gal.	.67 —	.70
White bleached Menhaden	gal.	.72 —	.75
Blown Menhaden	gal.	1.05 —	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	...
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	60.00 —	65.00
Caseine	lb	.14 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground f.o.b. Baltimore	net ton	27.00 —	30.00
Fuller's Earth, f.o.b. New York	net ton	16.00 —	17.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	...
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00 —	...
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	... —	.09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07 —	.09
Graphite, higher lubricating grades	lb	.11 —	.40
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic, lump	lb.	.06 —	...
Pumice stone, ground	lb.	.04 —	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1¼@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	1.00 —	1.05
Shellac, orange superfine	lb.	1.05 —	1.10
Shellac, A. C. garnet	lb.	.90 —	.95
Shellac, T. N	lb.	.85 —	.95
Soapstone	ton	15.00 —	25.00
Sodium Chloride	long ton	..... —	17.50
Talc, paper-making grades, f.o.b. Vermont	ton	12.00 —	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 —	15.00
Talc, rubber grades, f.o.b. Ve mont	ton	12.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	60.00 —	70.00
Talc, California Talcum Powder grade	ton	20.00 —	45.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100-110
Chrome cement, 40-45% Cr_2O_3	net ton	55-60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	60-65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45-50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.16 —	.17
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.17 —	.18
Ferro-manganese, 76-80% Mn, domestic	gross ton	140 00 —	145.00
Ferro-manganese, 76-80% Mn, English	gross ton	135 00 —	140 00
Spiegeleisen, 18-22% Mn	gross ton	60 00 —	65 00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.50
Ferro-silicon, 10-15%	gross ton	60 00 —	65 00
Ferro-silicon, 50%	gross ton	78 00 —	80 00
Ferro-silicon, 75%	gross ton	..... —	160 00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.65 —	.75
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7 00 —	...
Ferro-vanadium, 30-40% per lb. of contained V	lb	6.50 —	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than H4% moisture	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 50%, Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.60 —	65
Coke, foundry, f.o.b. ovens	net ton	..... —	7.00
Coke, furnace, f.o.b. ovens	net ton	..... —	6.00
Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00 —	26.00
Fluor spar, lump, f.o.b.Tonuco, New Mexico	net ton	17.50 —	....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50 —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¼
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	45 —	.50
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	35.00 —	....
Pyrites, Spanish, fines ,c.i.f., Atlantic seaport	unit	.12 —	....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.17 —	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	4 25 —	4.50
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.00 —	4.25
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.50 —	.....
Zircon, washed, iron free	lb.	.05 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	15.00
Aluminum, 98 to 99 per cent	22.00@33.00
Antimony, wholesale lots, Chinese and Japanese	5.62½
Nickel, ordinary (ingot)	43.00
Nickel, electrolytic	45 00
Tin, 5-ton lots	35.25
Lead, New York, spot	5.75
Lead, E. St. Louis, spot	6.25
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	6.75

OTHER METALS

Silver (commercial)	oz.	$0.63½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.40
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	75 00
Iridium	oz.	350.00@400.00
Palladium	oz.	75.00
Mercury	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	22.50
Copper bottoms	34.00
Copper rods	29.00
High brass wire and sheets	22.25
High brass rods	18.25
Low brass wire and sheets	30.50
Low brass rods	19.50
Brazed brass tubing	36.25
Brazed bronze tubing	41.50
Seamless copper tubing	26.00
Seamless high brass tubing	25 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	12 00	17 00	10 00	11 50
Copper, heavy and wire	11.50	16 00	9 50	11.00
Copper, light and bottoms	10 00	14.00	9 00	9 50
Lead, heavy	4 00	4.75	4 00	4 50
Lead, tea	3 00	3.75	3 00	3 50
Brass, heavy	7 00	10 50	7 00	10 50
Brass, light	5 50	7 50	5 00	5 50
No. 1 yellow brass turnings	6 50	10 00	5 50	5 50
Zinc	4 50	5 00	3 00	4.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3 80	$4 15	$3.47	$3 58	$3.37	$3.58	$3.47
Soft steel bars	3 70	4 15	3 37	3 34	3.27	3.48	3.37
Soft steel bar shapes	3 70	4 15	3 37	3 48	3.27	3.48	3.37
Soft steel bands	4 65	5 50	4.07	6 25	...	...	...
Plates, ¼ to 1 in. thick	4 00	4 15	3.67	3 78	3 57	3 78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

SPRINGDALE—The Welch Grape Juice Co., Portage St., Westfield, N. Y., plans to build a factory. Estimated cost, $375,000. J. F. Welch, vice pres.

California

BIGGS—The town is having plans prepared for the construction of a sewage disposal plant and filter beds, etc. Estimated cost, $60,000. C. E. Sloan, Nevada Bank Bldg., San Francisco, engr.

LOS ANGELES—N. Meyer, care of Los Angeles Soap Co., 633 East 1st St., has awarded the contract for the construction of a 1-story, 53x176-ft. garage on Washington and Union Aves., to C. W. Bean, 973 South Vermont St. Estimated cost, $17,925.

VISALIA—The town voted $55,000 bonds for the installation of septic tanks. L. H. Gadsby, city engr.

Illinois

CHICAGO—The Illinois Glass Co., Alton, is having plans prepared for the construction of cork plant here, to replace the one recently destroyed by fire.

LASALLE — Weightman & Steigely, archts. and engrs., 21 North La Salle St., Chicago, will receive bids March 1 for the construction of a 2-story, 80x350-ft. stoneware factory. Estimated cost, $200,000.

Michigan

ANN ARBOR—The University of Michigan, care of M. L. Burton, pres., plans to build a physics laboratory, $800,000 and a chemical laboratory, $400,000.

Minnesota

HACKENSACK—The Bd. Educ. will receive bids in January for the construction of a 2½-story, 95x102 ft. high school. A chemical laboratory will be installed in same. Estimated cost, $75,000. Libenberg, Kaplan & Martin, 615 McKnight Bldg., Minneapolis, archts.

STORDEN—The Bd. Educ. will receive bids about January 15 for the construction of a 2-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, $100,000. S. Anderson, Storden, clk. C. H. Parsons, 600 Builders Exch., Minneapolis, archt.

ST. PAUL—The Farmers Consolidated Distributing Co., 935 Andrus Bldg., Minneapolis, plans to build a 3-story, 75x125-ft. factory for the manufacture of powdered butter-milk, on Prior Ave. and Montague Pl. Estimated cost, $350,000.

New Jersey

MILLVILLE — The Whithall-Tatum Co., 46 Barclay St., New York City, is having plans prepared for the construction of a 2-story, 35x105-ft. factory for the manufacture of glass ware. R. W. Pollock, 1802 Chestnut St., Philadelphia, Pa., archt.

RIDGEFIELD—The Continental Paper Box Co., 122 Washington St., Brooklyn, N. Y., has awarded the contract for the construction of a 100x500 ft. factory on Grand and Hall Sts., to the Gretsch Eng. Corp., 103 Park Ave. Estimated cost, $250,000. Noted Dec. 15.

New York

BROOKLYN—The Grasselli Chemical Co., Guardian Bldg., Cleveland, O., plans to build a 1-story addition to its chemical plant near Newtown Creek, here. Estimated cost $100,000. Lockwood & Green & Co., 101 Park Ave., New York City, archts. and engrs.

FLUSHING, L. I.—The Bd. Educ., 500 Park Ave., New York City will soon award the contract for alterations, repairs, etc., to the sewage disposal plant at the New York Parental school, Kissena Rd., Reeves and Melbourne Aves.

Ohio

CLEVELAND — The Acme Petroleum Products Co., 3591 West 56th St., plans to build a 2-story factory. Estimated cost, $75,000.

Pennsylvania

EASTON—The city plans to build a sewerage system and sewage disposal plant. Estimated cost, $350,000. Hill & Ferguson, 112 East 19th St., New York City, engrs.

ELYSBURG—The Bd. Educ. is having plans prepared for the construction of a 2-story, 64x67 ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. W. H. Lee, 32 South 17th St., archt.

PHILADELPHIA—The Amer. Eng. Co., Wheatsheaf Lane and Speviva St., plans to rebuild its 1-story foundry which was recently destroyed by fire. Estimated cost, $20,000.

South Dakota

WAVERLY—The Bd. Educ. will receive bids about January for the construction of a 2-story, 80 x 109 ft. consolidated school. A chemical laboratory will be installed in same. Estimated cost, $100,000. K. T. Snyder, 739 Plymouth Bldg., Minneapolis, Minn., archt.

Texas

COLLEGE STATION—The Texas A. E. M. college plans to rebuild its mechanical engineering laboratory building which was recently destroyed by fire. Loss, $250,000. Dr. Bizzell, pres.

Vermont

WINDSOR—The Windsor Foundry Co. plans to build a 1-story 115x250 ft. foundry.

Wisconsin

GILMANTON—The Union Free High School will receive bids until January 28 for the construction of a 2-story, 85x140-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. E. J. Hancock, Eau Claire, archt. and engr.

IRON BELT—The Bd. Educ. will receive bids until Jan. 15 for the construction of a 2-story, 75x100-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, $80,000. Kelly & Shefchik, Alworth Bldg., Duluth, Minn., archts.

MAYVILLE—The Mayville Free High School Dist., is having plans prepared for the construction of a 4- and 5-story, 65x210-ft. high school on Main St. A physical and chemical laboratory will be installed in same. Estimated cost, $100,000. Parkinson & Dockendorff, Linker Bldg., LaCrosse, archts. Noted Nov. 3.

MILWAUKEE—The Panay Horizontal Show Jar Co., 1102 32nd St., will receive bids about Jan. 1 for the construction of a 2-story, 120x125-ft. factory on 32nd St. A. D. Koch, Wells Bldg., archt.

REEDSBURG—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. A. B. Olson, principal.

WAUKESHA—The Municipal Hospital, care of V. Tichenor, 831 Grand Ave., plans to build a hospital. A chemical laboratory will be installed in same. Estimated cost, $150,000.

WEST ALLIS — The Bd. Educ. was awarded the contract for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $431,539. G. A. German, principal.

Ontario

HAMILTON — The Canadian Sibbey Owens Sheet Glass Co. has awarded the contract for the construction of a 150x540 ft. sheet glass, to H. W. Cooper. Estimated cost, $1000,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE is holding its 1920 meeting **Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.**

AMERICAN CERAMIC SOCIETY **will hold its** annual meeting Feb. 21 to 24, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY **will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.**

AMERICAN ELECTROCHEMICAL SOCIETY **will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.**

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS **will hold its spring meeting Feb. 14 to 17 in New York City.**

AMERICAN PHYSICAL SOCIETY is holding its annual meeting, beginning Dec. 28, at Chicago, it being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA **will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.**

COMPRESSED GAS MANUFACTURERS' ASSOCIATION **will hold its eighth annual meeting, Monday, Jan. 17, 1921, at 2 p.m., at the Hotel Astor, New York, and its eighth annual dinner at the same place that evening.**

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetter's Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY **holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14, 1921.**

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25 Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

BLAW-KNOX CO., Blawnox (Pittsburgh), Pa., has established a new sales district in the South, with headquarters at 408 American Trust Bldg., Birmingham, Ala. In addition the Blaw-Knox Co. has district offices in New York, Chicago, Detroit, Boston, Baltimore, San Francisco and Sheffield, England. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of the new office.

THE KALYPTOL CHEMICAL CO., of 784 Broad St., Newark, N. J., with Benjamin F. Jones as agent, has filed a certificate in the office of the Secretary of State amending its charter so that the capital stock of the concern has been increased from $250,000 to $500,000, divided into 20,000 shares of preferred at $10 each and 30,000 shares of common stock at $10 each.

THE OXWELD ACETYLENE CO. announces the appointment of the Standard Supply & Equipment Co., of New York and Philadelphia, as eastern sales agent for Eveready welding and cutting apparatus and supplies.

THE HEROLD CHINA & POTTERY CO., Golden, Col., changed its name Nov. 15, 1920, to the Coors Porcelain Co. This company manufacturers Coors-U-S-A chemical and scientific porcelain.

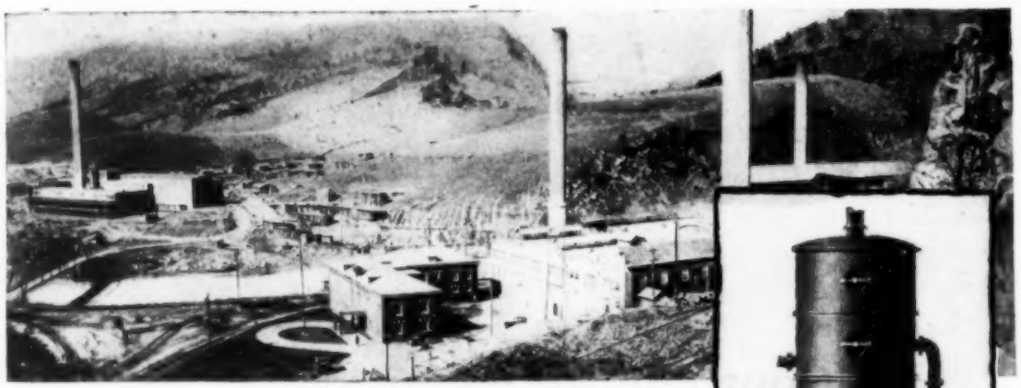
THE ILLINOIS GLASS CO. has just started operations of its new factory at Bridgeton, N. J., by warming in the first two automatic bottle-blowing machines. The company plans to bring production at the Bridgeton plant up to the point where it will equal the large plant at Alton, Ill.

For Continuous Operation
For Lowest Power Consumption
For Longest Refractory Life
For Lowest Electrode Consumption
For Lowest Freight Cost
For Lowest Operating Cost

ACHESON ELECTRODES

ACHESON GRAPHITE COMPANY
Niagara Falls, N. Y., U. S. A.
E. G. Acheson, Ltd., 40 Wood Street, Westminster, London, S. W. 1, England
Takamine Shoji Kaisha, Tokyo, Kaijo Bldg., Tokyo, Japan

GLAMORGAN



For Economy in the use of raw materials —and labor saving,

MOUNT

Continuous Causticizing Apparatus

The complete plant which we furnish consists of a continuous causticizer, decanter, rotary filter, rotary kiln, gas producer, lime slaker and auxiliary apparatus such as vacuum pump, lime and liquor pumps and sludge agitator.

This apparatus is the work of our consulting engineer, for 25 years general manager and chief designing engineer of one of the large alkali plants of the country. Six years' operation has proven its success.

All apparatus is of heavy construction, the process continuous, and steam consumption a minimum. Exhaust steam at 10 pounds pressure can be employed, instead of live steam.

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We place at the disposal of executives in the chemical field the services of our consulting engineers for the production of equipment to meet any given needs.

GLAMORGAN PIPE & FOUNDRY CO.

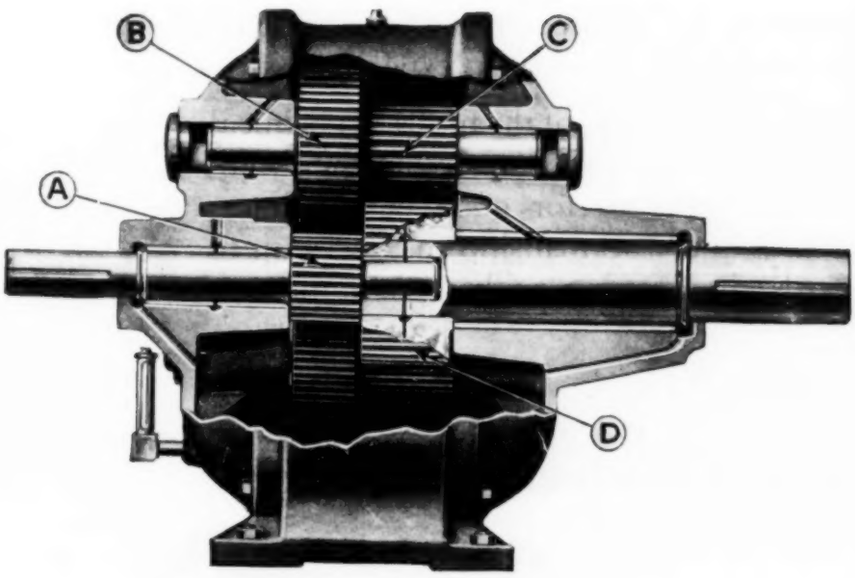
Sole Manufacturers

Lynchburg, Va., U. S. A.

Jones

Spur Gear

Speed Reducers



A—Pinion on high-speed shaft meshes with and drives three gears B. B—Gears are mounted integral with three pinions C. C—Pinions mesh with and drive gear D, mounted on slow-speed shaft.

The mechanism of the Jones Reducer has been acknowledged by engineers to be the best solution of all speed reduction problems. One glance shows hows completely it eliminates the mechanical weaknesses inseparable from internal gears and overhung shafts. A bearing for the high-speed shaft is provided in a bronze bushed hole at the end of the slow-speed shaft, which is shown on the right.

Though the installation is singularly compact, reductions are possible up to a ratio of 200 to 1, and over. The mechanism is entirely enclosed in a cast iron, acid-proof, dust-proof housing—a prime requisite in a chemical plant.

Write today for Reducer Bulletin. Our engineers are at your service.

W. A. Jones Foundry & Machine Co.
4416 West Roosevelt Road, *Chicago.*
New York 20 Murray St.

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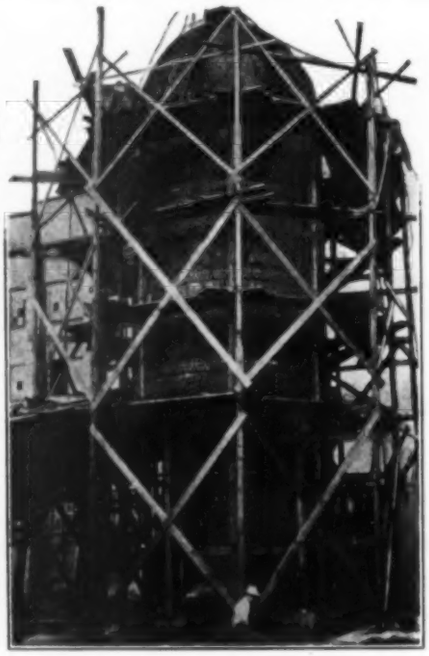
Manufacturers of cast iron pulleys, gears of all kinds, couplings, Lemley friction clutches, pillow blocks, hangers, speed reducers and general power transmission machinery.



Manitowoc Digester in the course of erection.

MANITOWOC EQUIPMENT

Dryers, Digesters, Tanks, Mixers, Incinerators, Retorts, Galvanizing Kettles and other heavy plate work

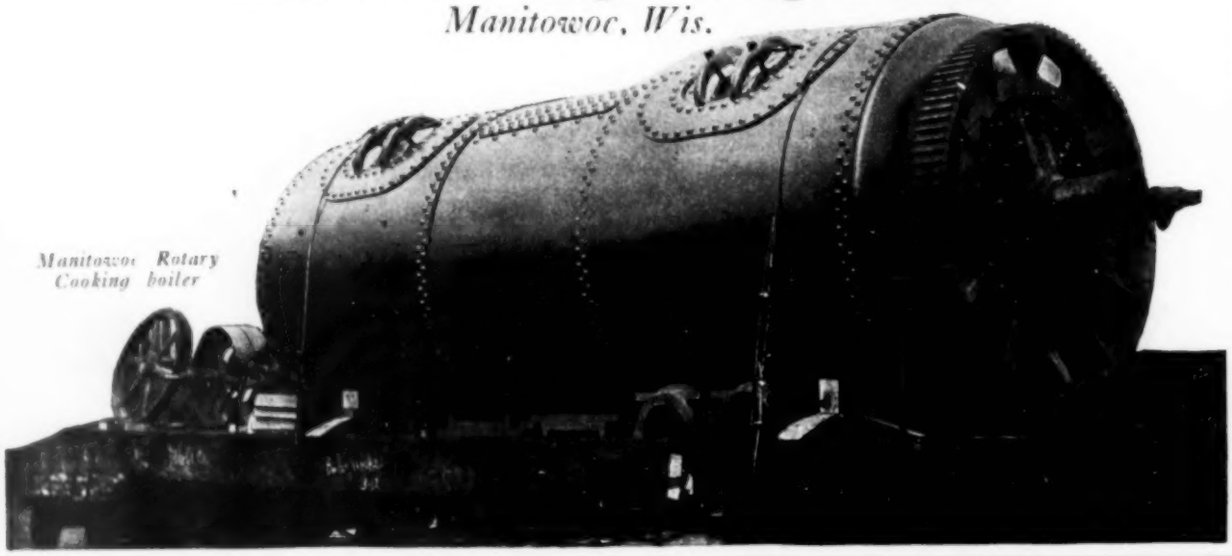
Chemical Equipment for satisfactory service must be made by experts on designs based upon experience.

Backed by thorough knowledge of the needs of chemical industry installations, equipment made in the Manitowoc shops is the standard for good performance. Quality of materials and workmanship measures up to the best standards, in keeping with the Manitowoc reputation.

Heavy plate work of all kinds.

Manitowoc Engineering Works

Manitowoc, Wis.



Manitowoc Rotary Cooking boiler

Why technical men hold themselves back

"A great many engineers are unconsciously holding themselves in check because they fail to grasp business principles."

—John A. Harrington, of the Executive Committee, American Association of Engineers.

WHAT Mr. Harrington and other engineering authorities are saying about the importance of business training for technical men, the Alexander Hamilton Institute began emphasizing years ago.

The Institute was founded by a group or business leaders who recognized that modern business was training specialists but was not developing executives in proportion to the constantly increasing demand.

From the first it has been an axiom with the officers of the Institute that "a technical man is the ideal Institute man"; and that axiom has proved itself in the fact that out of the army of men whom the Institute has enrolled one in ten is a man of technical training or interest.

The men of whom presidents and general managers are made

Just what is it that the Institute has done for these thousands of engineers and technical men. Let us illustrate very specifically:

You are an engineer, a chemist, a draughtsman, a master-mechanic—in a word, a man who has reached his present position in business thru specialized training of one sort or another.

You can see your way clearly to a place at the head of your department; but beyond that what does business have in store for you?

Do you know the fundamentals of accounting? Of merchandising and advertising; of factory and office organization; of business law and corporation finance?

These fundamentals a man *must* know if he is to direct an organization, or engage in business for himself.

And it is precisely these essentials that the Institute—thru its Modern Business Course and Service—undertakes to give—not in years, but in the spare moments of a few months.

No man could run thru the letters

contained in the Institute's files without feeling that here is an opportunity which every man of technical training ought to investigate, at least.

Here is a sentence from the chief engineer of a great port city, for example: *"I know of nothing that could tend more towards the advancement of an engineer on any line of work than a thoro study of Modern Business."*

And another from a resident engineer, of a giant engineering company: *"The engineering profession is broadening, and men trained as engineers are more and more being used in business where their technical education gives them an excellent groundwork."*

"Your training enabled me to effect economies in my work which I had not dreamed of before," says a prominent electrical engineer. And other men, in every phase of technical work, are on record with equal positiveness and enthusiasm.

To save the wasted years

The Alexander Hamilton Institute has only one Course and one product—trained executives. It does not claim to be able to transform failures into successes; its interest is with the man who would ultimately score a fair measure of success even without its help.

To such a man it says: "There is a shorter road to one of the important positions in business than merely routine experience; thousands of men have proved that truth thru their own experience and success.

"You know better than anyone else what a year of your life is worth. But if the Alexander Hamilton Institute can save five years for you that would otherwise be lost in a routine job, or three years or even one, surely that promise is worth your investigation."

Investigation is easy; you have merely to send for

"Forging Ahead in Business"

Forging Ahead in Business is a book of 116 pages. Into it have gone the results of years' experience in helping men to success. It answers every question you can raise about the Alexander Hamilton Institute; it contains letters from men whose positions in business were very similar to yours. It is a book that should be in every man's library, and there is a copy for every man of serious purpose. It is sent without obligation; send for your copy today.

Alexander Hamilton Institute
29 Astor Place, N. Y. City

Send me "Forging Ahead in Business" which I may keep without obligation.

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Print Here
Business Address.....

Business Position.....

Canadian address, C. P. R. Bldg., Toronto: Australian address, 8a Castlereagh St., Sydney

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For Economical Shipping of Oils, Dyes, Paints and Greases

For Proper Handling of Chemicals, Inks, Semi-Solids and Powders

Removable Head Steel Barrel

Here's Your Economical Shipping Package

You can walk up to this barrel, give the lugs a half turn and easily remove the head by means of the sturdy handles. It's a Perfect Metal Bilge Barrel.

We put the handles where you want them to fit your particular requirements.

We fasten our special type of lugs right to the barrel so there is no danger of coming off or being lost.

These features are much appreciated by big shippers of chemicals, inks, dyes, paints and greases, the semi-solids or powders. They like this liquid leak proof barrel.

But better even than these handy helps is the rugged sturdiness of the barrel itself. It's made of special steel and given a special chime construction five times average strength. The bumps and jolts ruin the chime of inferior barrels, cause leaks, losses and replacements. The chime of this barrel is not liable to distortion so the head is always removable and always efficient.

You can forget shipping troubles with Perfect Metal Bilge Barrels.

They're made in closed head type too and we make Detroit Light and Heavy Steel Drums.

For All Round Easy Handling

No easier-to-handle shipping container was ever shipped, rolled, skidded, stacked or piled. The perfect chime provides a real hand grip that a fellow can take hold of and hold on to. Proper spacing—owing to the bilge shape—saves your men's fingers, their time and their temper.

Removable Head Type

Safely Carries Costly Products

Perfect Metal Bilge Barrels are safe—safe enough that certain dealers in precious metals ship thousands of dollars worth in one single package.

These barrels save leaks, else there would not be so many thousands in use by shippers of costly chemicals, dyes and kindred products.

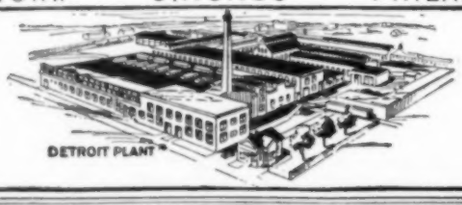
Guaranteed for three years but will last ten

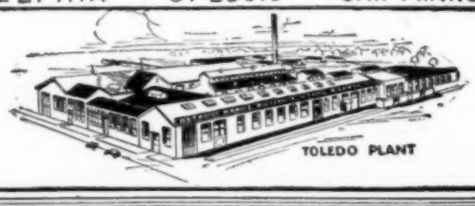
Write for catalogue of these money saving containers.

Detroit Range Boiler & Steel Barrel Co.

DETROIT MICH

NEW YORK CHICAGO PHILADELPHIA ST LOUIS SAN FRANCISCO





TITANIUM TALKS

No. 25

What Caused These Rust Spots?

After calling attention to certain structural differences, which might possibly have had some effect on the failures, the report concludes:—

"There is a stronger indication in these samples, however, that slag inclusions near the surface of the tin-plate had a decided influence in starting the rust spots, probably by causing the tin coating to be porous at these points on account of disturbances due to the slag during pickling and tinning. Of course the electro-chemical reactions between tin and iron would be expected to cause corrosion of the iron wherever the tin coating was broken. The conclusion then is that the steel in this case was of inferior quality."

The Titanium Alloy Mfg. Company

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Pittsburgh Office, Oliver Building
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FERRO CARBON TITANIUM F.C.T.

New York.

Chicago Office,
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T. Rowlands & Co., Ltd., Sheffield, England, Agents for Great Britain and Europe

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99½ Per Cent Pure

We are prepared to serve you promptly.

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Guaranteed 99% Pure

For use in Metallurgical field, etc.

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Specialty Imperial Chrome Ore

The well known refractory ore for furnace linings. Lump, low in Silica and low in iron.

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Cyanide (For case hardening)
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94-98%
AND
Manganese Alloys
(Including 30% Manganese Copper, Manganese-Titanium, Manganese-Aluminum, and Manganese Boron)

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Tonopah, Nevada, U. S. A.

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For Users of

ALKALIES

Solvay Technical Service is rendered by a staff of specialists devoted solely to the study of the proper use of alkalies in all the processes which they enter.

These men are practical chemists and know alkalies from start to finish—their uses, properties and capabilities to do a given job. They will help you on request on any problem of manufacture, of textile finishing, of water softening, of cleansing, or of mere chemical analysis. If you wish, a representative will call on you.

Write us for our Technical Bulletins, giving our standard methods for analysis of alkalies and treating of other pertinent related subjects.

The Solvay Process Co.

Technical Service Department

Syracuse, N. Y.

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CAUSTIC SODA
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SOLVAY SNOW-FLAKE CRYSTALS
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Trouble ahead—when you find that your last order for your favorite Flotation Oil cannot be duplicated.

Barrett Flotation Oils never fail you, every barrel is just as good as the last. Always uniform in high-grade quality—always available in any quantity you need.

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for Chemical and Metallurgical Uses in standard or special forms.

Platinum scrap purchased or exchanged

J. Bishop & Co. Platinum Works
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LIGNONE

Made from sulfite cellulose liquor.
A colloid of varied uses.

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Do you understand what that means to you as an advertiser?

It means that you get a "square deal" when you buy our circulation. It means that the net paid distribution of **Chemical and Metallurgical Engineering** has been verified by the only recognized authority on circulation.

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Metal Cyanides and Trisalyts for Electro Plating

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Our container equipment includes a fleet of tank cars, one ton drums, 150 and 100 lbs. Cylinders.

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will be interested in the results of a research recently completed at the University of Michigan.

It shows how

SILICON

may be determined, much more easily and quickly than by the methods generally employed.

Perchloric Acid No. 1, C. P.
$HClO_4$
60% by weight
Sp. G. 1.54
1 Pound
GENESEE CHEMICAL COMPANY
BATAVIA, N. Y., U. S. A.

←THIS

will help to do it, and we will be glad to send you the method.

Just tear this out, and write your name on it.

Johnson

43rd Year

Over 15,000 in Service

Filter Presses
——what they avoid——

MACHINES, like men, are often noted as much for the common mistakes they avoid as for their more positive virtues.

So well adapted in design, material and construction is a "JOHNSON" to the task in hand that an owner who has had experience with no other is astonished to have friendly competitors inquire as to how some obstinate filtration problem is handled. "JOHNSON" owners have no "problems"—obstinate or otherwise—

—no moist cakes
—no sewing on of cloths
—no high-priced skilled labor
—no moving parts
—no waste of valuable filtrates
—no long lay-ups for rewinding cloths
—no vacuum apparatus
—no clogging — no unwashed cake—no wastes
—no leaks—no breakdowns or holdups.

Just "JOHNSON"—Johnson Engineers assume all the burdens of the filtration problem. And "JOHNSON" Filter Presses solve it. Consultation service is freely at your disposal, and without obligation.

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A filter may be theoretically of the highest efficiency and economy and practically give excellent results as compared with old methods of handling, but unless it is of the best construction, both as to design and material used, it is a poor investment.

Zenith filters stand far superior to all others in perfection of design, strength of construction, minimum cost of operation and low items of repair and renewal.

Highest Capacities!

Lowest Moisture Content!

Most Excellent Wash!

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(Patented)
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General and Exclusive Licensee to the Kelly Filter Press for all industries, with certain exceptions in the entire United States East of Colorado.

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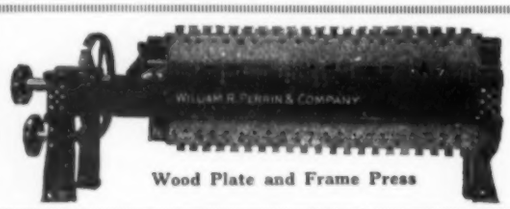

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FILTER PRESSES
We make all sizes from 18 inches to 40 inches square.
For acids and chemicals where liquids should not come in contact with metal
Write for Information and Prices
William R. Perrin & Company — Chicago, Illinois
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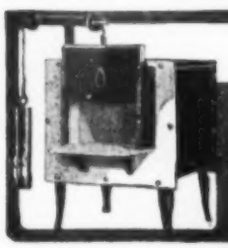

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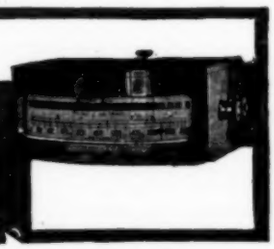
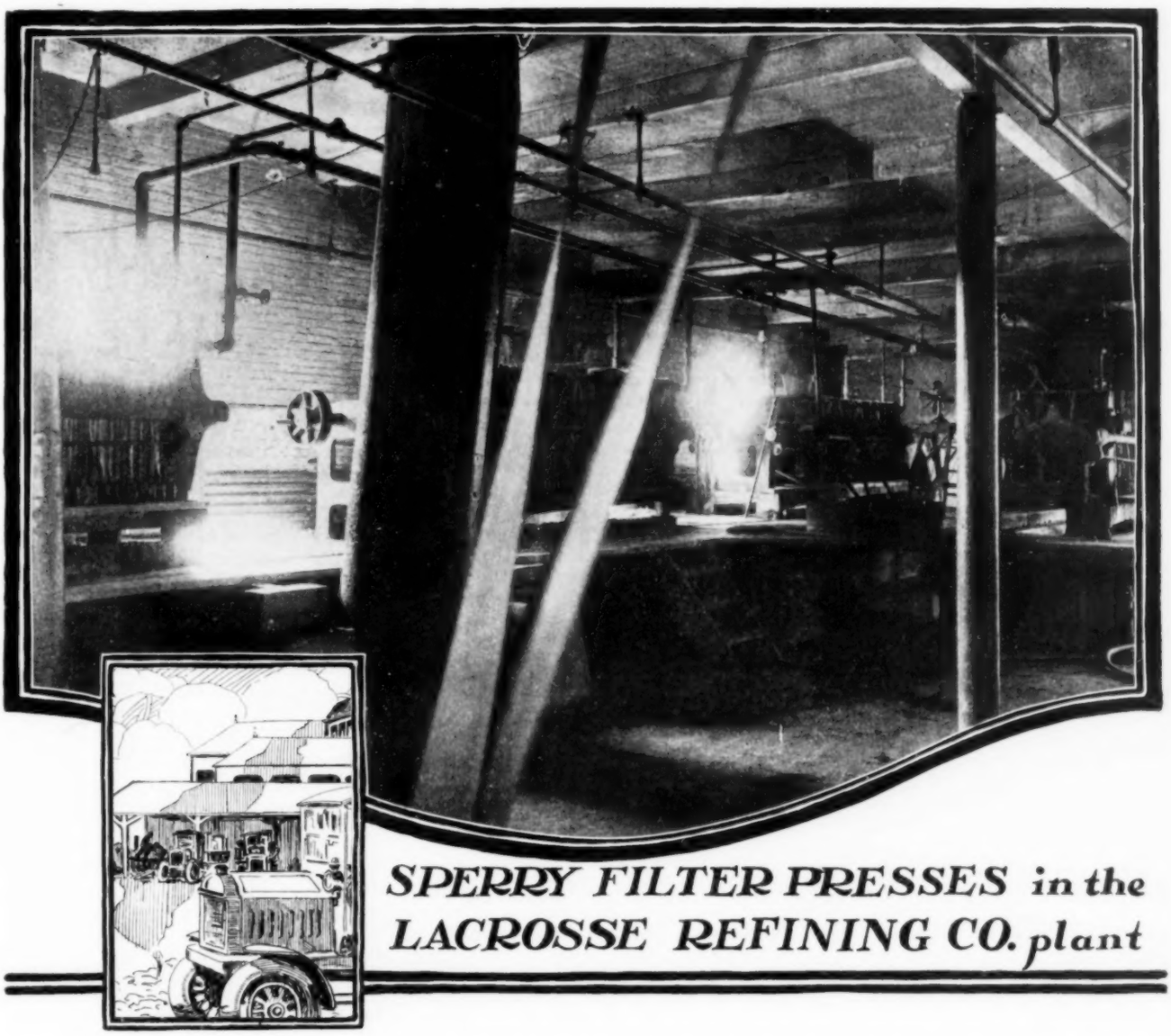
ELECTRIC FURNACES - PYROMETERS

Hoskins Electric Furnaces and Pyrometers are found in the majority of modern plants and their laboratories. Write to Hoskins Manufacturing Company Detroit, for complete information.





SPERRY FILTER PRESSES in the LACROSSE REFINING CO. plant

This photograph was taken in the plant of the La Crosse Refining Co., at La Crosse, Wis., and shows a battery of four 36 inch Sperry Filter Presses that have been in operation at this plant for the past several months.

These presses are used in a Maltose syrup manufacturing process and according to the man in charge of the filter press department, results obtained have been entirely satisfactory in every way.

There are eleven Sperry Presses in this plant.

Write to the Sperry Engineering Department when difficult filtering problems are confronted. The Sperry Filter Press Book will be mailed free upon request.

FILTER CLOTH

Our Filter Cloth Department is prepared to supply all your needs, either in sewed cloths or in rolls. Write today for prices.

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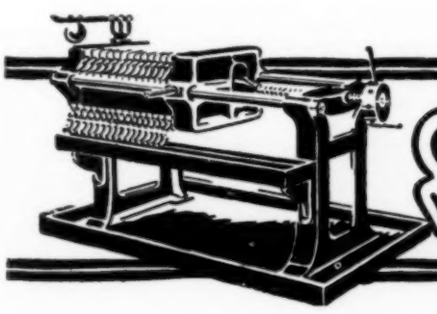
BATAVIA (Near Chicago), ILL.

Pacific Coast Representative: B. M. Pilhashy, 1137 Hyde St., San Francisco, Cal.
New York Agent: H. E. Jacoby, 95 Liberty Street



SPERRY FILTER PRESSES

INDUSTRIAL FURNACE CORPORATION
E FLAMMA PROGRESSUS

Out of Flame—Progress

is the motto of our trade mark, which dates back hundreds of years in the basic elements of its design.

The conception of service upon which we are organized is as equally well grounded. The Industrial Furnace Corporation is prepared to fully protect your investment in furnace plant, by selecting and installing the complete furnace equipment, and thus assuming a responsibility which enables the giving of a blanket guarantee of overall results.

Industrial Furnace Corp.
10 Postoffice Square, Boston, Mass.

American Transformers

Made for Your Particular Job

Before we sell you a transformer we study the use to which it is to be put—then design it to do that particular job.

That's why our "custom made" transformers have individuality in the transformer field.

Our broad engineering experience in the chemical and metallurgical field will prove valuable to you. Send us complete information and let our engineers figure on your problem.

The American Transformer Company
Office and Works:
182 Emmet Street, Newark, N. J.

HIGH-GRADE CLEARFIELD COUNTY FIRE BRICK AND DUST

BRANDS	CAPACITY
"CRESCENT"	275,000
"LIBERTY"	Nine-inch
"LUMBER CITY"	equivalent
"ROCKTON"	daily
"SUSKANA"	
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PRODUCTS:

Crucible Furnace Linings
Blast Furnace Linings
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High Duty Special Shapes

CRESCENT REFRACTORIES COMPANY

Curwensville, Clearfield County, Pennsylvania
Plants: Curwensville, Pa. Lumber, Pa. Clearfield, Pa.

CHAIN DOORS
Hinder chilling furnaces in winter when charging
"Keep Cold Out and Heat In"
E. J. CODD CO., Baltimore, U. S. A.

The Walter E. Lummus Co.
Chemical Plant and Refinery
Engineering and Complete Construction
See our large advertisements every other week.
173 Milk Street, Boston Factory: Everett, Mass.

DON'T WAIT—

Until the equipment in your plant is shut down for lack of work, and then plunge into a wild scramble to advertise for more business. Busy or slack, keep advertising steadily, week by week, month by month, and you'll keep the wheels a-turning.

It's the REPEATED SUGGESTION *that Counts.*

TRADE MARK

Electric HEVI DUTY Furnaces

Reg. U. S. Pat. Off.

Type HD1014
CRUCIBLE FURNACE

Top opening, 10 in. square, 14 in. deep. Full load rating 7.0 K. W. Attains 2000 deg. F. in 1 hour and 25 minutes. At 2000 deg. F., 1800 deg. F., and 1400 deg. F. the furnace holds 2.86 K. W., 2.35 and 1.21 K. W., respectively, per hour.

Has four interchangeable coils and four interchangeable Crucible Plates. Coils No. 4 B & S gauge wire, .204 in. diameter.

Switches on panel give 72 points of temperature control 500 deg. F. (260 deg. C) to 2000 deg. F. (1100 deg. C.)

DIMENSIONS (in inches) AND WEIGHTS (in pounds)

TYPE	SIZES OVER ALL Width	Height	Depth	NET WGT	SIZES BOXED	SHIPPING WEIGHT
Furnace	22	31	22	265	42 x 29½ x 30	415
60 cyc. Transf'er	13	43	16	280	15½ x 23½ x 46	370
25 cyc. Transf'er	13	47	20	525	15½ x 27 x 50	630

Price Complete, 60 Cycle, $465.00. 25 Cycle $510.00.
Consult Dealers or Write Direct

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Type HD 1014 Crucible Furnace complete with Regulating Transformer

QUIGLEY POWDERED COAL SYSTEM

Reliability
Cleanliness
Economy

The only system where accurate records of fuel consumption are made possible and where pulverized coal can be transported long distances with absolute reliability and cleanliness.

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can be as economically run with Pulverized Coal as the large plant. Write us for details of the Aero Unit System of Pulverized Coal.

Backed by the Longest Successful Service

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Absolute protection for your machinery against tramp iron is assured by their use. Write for details.

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HAGAN *(American New Model)*
UNDERFEED STOKER FIRED FURNACES

Make no payments on Hagen (American New Model) Underfeed Stoker fired furnaces until these guarantees have been fulfilled:

Fuel saving over hand firing—15% to 50%.

Saving over cost of producer gas—30%.

Heat units from each ton equal to from 23,000 to 25,000 cubic feet natural gas.

Heat units from 12 to 14 pounds common slack coal, equal to one gallon fuel oil.

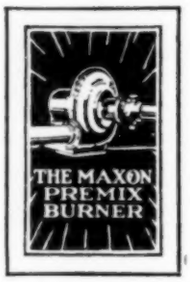
Upkeep cost, including power and labor, will not exceed 17 cents per ton of coal consumed

Geo. J. Hagan Co.

Peoples Bank Bldg., Pittsburgh, Pa.

Sales Agents for Combustion Engineering Corp.

The Perfect Furnace for the Perfect Fuel



You'll agree that oil is the cleanest, most efficient fuel obtainable if the furnace is all that it should be.

To this end we invite investigation of the Maxon Premix Burner. It burns *all* the oil all the time without high pressure air for atomization. The result is steady, complete combustion with a maximum number of heat units liberated *in the right place.*

Our engineers will help you install the proper burners on your furnaces.

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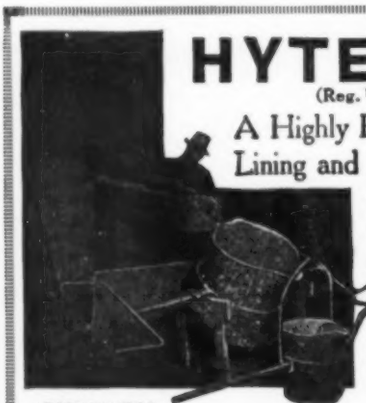

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A Highly Refractory Cement for Lining and Patching CUPOLAS, Cupola Spouts, LADLES, Pit Furnaces, Making Rammed-in Linings and SPECIAL TILE and as a Core Wash. It air-sets, stands high temperatures, and has great binding strength.

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Ajax-Wyatt Electric Furnaces

are revolutionizing the making of yellow brass.
Metal loss reduced ½ of 1%.

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You may obtain from us all kinds of Stopcocks, 2 and 3 way; diameter of plug 1-6 mm., also other styles.

You will save money by writing us for prices.

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FREAS Electric Ovens, Incubators, Water Baths, etc.

Scientifically constructed. Economical, durable.

Absolutely automatic and require no attention over long periods of unattended operation.

For sale by dealers in dependable laboratory apparatus.

Manufactured by

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(formerly Booth-Hall Co.)

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PULVERIZED FUEL INSTALLATION
Furnace Work—Fuel Economy
COMPLETE WIRE DRAWING MILLS

FOR ROPE WIRE POULTRY NETTING WIRE
BRASS and COPPER WIRE, Etc.

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Operates on a new principle. Arc acts on the bath in a large flame. Widely used for making steel, melting brass, copper, nickel and ferro-manganese. Built in the following sizes: 300 lbs., 1000 lbs., one gross ton, 2 gross tons and 3 gross tons.

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Guaranteed to 3,100° F.

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Patented Jan. 13, 1920.

Furnace Cement

Made to withstand high temperature. Positively does not deteriorate or lose its high refractory properties in service. Outlasts other linings. Ideal for repairing and patching. Easily molded into blocks for special shapes. Eliminates clinker trouble.

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A Powers Automatic Heat Regulator saves labor, by mechanically, controlling temperatures, as required, thus relieving operatives for work which machines can't do. It also positively prevents the ruin of material through overheating or underheating. The Powers Regulator never forgets—never procrastinates—never shirks. It controls the heat—keeps it where you want it—all the time.

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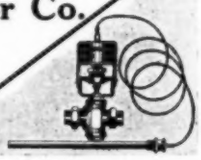

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SILICON—MANGANESE

20/25% Sil., 48/52% Mn.

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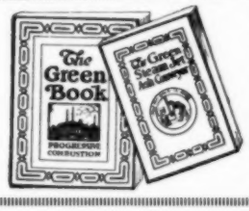

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Green Steam Jet Ash Conveyor Booklet. 32 pages of easy reading that reaches straight to the heart of the ash disposal question. Illustrates and explains the Green Steam Jet and the Cast Iron Ash Tank. *Dept. F will send either or both of the above books on request.*

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Moore Rapid 'Lectromelt Furnaces

—for ferro-alloys, carbide and smelting
—for steel, cast or malleable irons
—for brass, bronze and non-ferrous metals

are the most rapid and efficient furnaces made.

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Produce More Metal—Higher Quality at Less Cost—Improved Mechanical Design

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DON'T EXPERIMENT—*BUY* COATESVILLE BOILERS

COATESVILLE BOILER WORKS

Manufacturer

New York, 30 Church St. Coatesville, Pa. Philadelphia, Morris Bldg.

THE MERRILL PROCESS OF INDUSTRIAL HEATING

For the quantity production of quality products with safety and economy

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Drying in a One-Man Plant

You can dry your product from the liquid state to a dry finished product in a one-man plant *in* 3 *seconds!*

1. Drying costs run as low as Fourteen One-Hundredths of a Cent a pound for dry powder—this covers Power, Heat and Labor.
2. The first cost is about one-half that of a high grade Vacuum Drum Dryer of equal capacity.
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FLEISHER SPRAY DRYER

"For all Kinds of Material"

W. L. FLEISHER & CO., Inc.

Air Conditioning and Drying

31 Union Square, New York, N. Y.

Type "E"

Buckeye Dryers are used for drying all classes of material which can be passed through a rotary dryer.

Made in many sizes and types for direct or indirect heating.

We solicit your correspondence relative to any drying problem before you.

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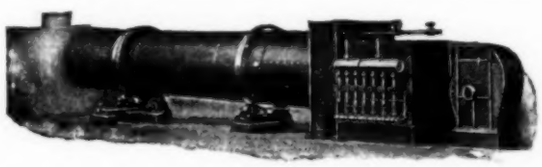
B. P. Goldman, 220 West 42nd St., New York, N. Y.



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For Chemicals

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Ask Us About The Paxson Dust Collector

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Air Purifiers, Gas Cleaning, Dust Collection, Pneumatic Transporters

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Let Sirocco Engineering Service solve your ventilating, heating and cooling problem. Send for catalog.

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STOKES ROTARY VACUUM DRYERS

are equipped with Patented Spiral Agitators

Low Power—Efficient Agitation—Rapid
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Standard and Special Types of Equipment to fit the particular conditions of *your* process.

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Blowers *Exhausters*

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FOR NEARLY ALL MATERIALS

Cottrell Electrical Precipitation Processes

For the precipitation and recovery of smoke, fume, dust, mist or vapor from chemical plant processes.

No matter how difficult your problem has been adjudged to be the Cottrell Processes can handle it—economically.

Our engineers will gladly investigate your problems and report on the best method of handling them.

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Kestner Evaporators

Simple Economical Efficient

Resines
Super-Filters
No Choking
No Cloths To Wear Out

Our Chemical Laboratory
is well equipped to help you with your *Process Problems.*

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CABINET TRAY DRYER—for drying small quantities of all kinds of materials. Rapid, efficient, labor and time-saving.

"HURRICANE" DRYERS

The Best Solution for Your Drying Problems

"HURRICANE" DRYERS have successfully tackled all kinds of drying problems in the following industries: Paint, Dyes, Chemicals, Food Products, Textiles, Porcelain, Potteries, Spark Plugs, Storage Batteries, Abrasives, Electrical Porcelains, etc.

You can not find the best solution of *your* drying problems until you investigate what the various types of "HURRICANE" DRYERS can do for you.

Send for Bulletin Chem-2

The Philadelphia Drying Machinery Co.
Philadelphia, Pa.

Main Office and Works:
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Boston Office: 53 State St.

"Hurricane" Truck Tray Dryer

Proctor Dryers
Helped the Business Grow

In 1918 the Imperial Color Works, manufacturers of high-grade colors at Glens Falls, N. Y., installed a Proctor truck tray type dryer. This machine gave satisfaction from the very first. So thoroughly, uniformly and economically did it handle the material, that the Imperial Color Works wrote us, "we are hopeful that the output of our plant will increase to such an extent that we will require an additional dryer."

Their hope was realized. A few months later, the second dryer was installed. Again the output of the plant increased so that additional dryers were needed. Four dryers now meet the requirements.

The Proctor Dryer mechanicalizes the drying process, and for this reason speeds up the entire plant. If you would obtain greater production at less cost, with a tremendous saving in time, labor and floor space, write us. State the quantity of material to be handled.

PROCTOR AND SCHWARTZ, INC.
Formerly Phila. Textile Mach. Co.
PHILADELPHIA, PA.
Chicago New York
Charlotte Providence
Hamilton, Ont., Canada

"Proctor" DRYERS

203

AIR CONDITIONING TRADE MARK

"A Happy New Year"

can be assured in every Industrial Plant if manufacturing and working conditions are properly considered.

More and a better product will be your output if you install Apparatus for Maintaining Artificial Atmospheric Conditions.

Uniform temperature and humidity throughout the year can be maintained regardless of climatic changes and an interview with one of our Engineers will bring out the facts as they apply to your particular case.

SPECIALISTS IN
HUMIDIFYING—DEHUMIDIFYING
COOLING—DRYING—AIR WASHING
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ATMOSPHERIC
CONDITIONING CORPORATION
LAFAYETTE BLDG.
PHILADELPHIA

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HIGH prices of materials and increased overhead have made necessary a stricter economy along mercantile lines.

Advertising should be considered as well as the commodities in which merchants deal.

By chosing only those publications whose circulation is accurately measured, you not only practice economy in your advertising, but are assured that your money is buying a definite quantity of circulation.

Chemical & Metallurgical Engineering's circulation is measured by the Audit Bureau of Circulations. Advertising placed in its columns is an economical investment.

CHEMICAL AND METALLURGICAL ENGINEERING

Think "SEARCHLIGHT" First

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POSITIONS WANTED—Evening work wanted, tutoring and other undisplayed ads of individuals looking for employment, 4 cents a word, minimum 75 cents, **payable in advance.**

ADD 5 WORDS for box number in undisplayed ads if replies are to any of our offices. There is no extra charge for forwarding replies.

DISCOUNT OF 10% if one payment is made in advance for 4 consecutive insertions of undisplayed ad.

ADS IN DISPLAY TYPE—Space is sold by the inch (30 in. to a page), the price depending upon total space used within a year, some space to be used each issue.

RATE PER INCH for ads in display space:
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4 to 7 in., $4.30 an in. 30 to 49 in., $3.80 an in.
8 to 14 in., $4.10 an in. 50 to 99 in., $3.70 an in.

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POSITIONS VACANT

POSITIONS WANTED

POSITIONS VACANT

ASSAYER wanted: Man who has had some experience in the assay of gold, silver and the platinum metals preferred. Location in the near vicinity of New York City. Applicant will give particulars as to religion, age, experience and salary expected. P-876, Chem. & Met. Engrg.

CALIFORNIA laboratory supply house wants high-class man to take charge of department handling sales of chemical, physics and general scientific materials. Must have executive ability, pleasing personality and be a man who can accomplish thinks. Only one who has thorough commercial knowledge of line from mercantile standpoint and good executive and business training need apply. State age, if married or single and salary expected. Give record of experience with names of former employers. Address, James O. Sully, Agent, Newhall Building, San Francisco.

CHEMICAL engineer wanted thoroughly conversant with and having practical experience of construction and operation of plant for the manufacture of phosphoric acid and its compounds. P-204, Chem. & Met. Engrg., Old Colony Bldg., Chicago.

EXPERIENCED mechanical-chemical engineer: Chemical plant equipment manufactuing concern needs an experienced engineer to function with sales department in handling projects, also for designing, specifying and equipment standardization. Must be university graduate with at least five years' experience, preferably along distillation, evaporation and extraction lines. P-201, Chem. & Met. Engrg.

EMPLOYMENT SERVICE

EXECUTIVES qualified for salaries of $2,500 to $25,000 and upward are invited to communicate in strict confidence with the undersigned, who will conduct preliminary negotiations for such positions. The procedure used is peculiar to this service, differing essentially from all others and is constructive and initiative; applied individually, and in no way jeopardizing present connections. Established 1910. Send name and address only for particulars. R. W. Bixby, Inc., 312 Lockwood Building, Buffalo, New York.

POSITIONS WANTED

CHEMICAL engineer, young graduate with plant and laboratory experience desires position with future; highest references. PW-167, Chem. & Met. Engrg.

CHEMICAL or dye works—Would you like to decrease your equipment troubles or devise cheaper methods? My 15 years general and three years specific dye and intermediate work has demonstrated my ability in such lines. Have developed some good things and have more in mind. Drying, agitation, pumping, materials handling. Studied English dye works; member Am. Chem. Soc.; available immediately; salary $5,000. PW-188, Chem. & Met. Engrg., Real Estate Trust Bldg., Philadelphia.

POSITIONS WANTED

CHEMICAL and metallurgical engineer, graduate, thorough theoretical training; many years' practical experience in laboratory and plant from chemist to manager. Inorganic or non-ferrous metallurgy. PW-202, Chem. & Met. Engrg., Old Colony Bldg., Chicago.

CHEMICAL engineer, B.S. in Ch. E., M. S.; available about Feb. 1, with four years in engineering research and process development with incidental analytical experience, wishes responsible position, preferably with chemical machinery manufacturers, consulting firm, or plant research department; especially interested in heat transmission, evaporation, and wet chemical processes and machinery. PW-213, Chem. & Met., Old Colony Bldg., Chicago.

CHEMIST, B.S., experienced leather chemist and practical tanner with good general knowledge fertilizer industry desires responsible position with advancement. PW-209, Chem. & Met. Engrg., Real Estate Trust Bldg., Philadelphia.

CHEMIST and metallurgist, graduate, age 27, thorough metallurgical anaylst and metallographis; wide experience, including five years of iron and steel analysis, physical testing and heat treatment. Took charge of laboratories for two years with finest automobile concern in the country; excellent references; desires responsible position. PW-141, Chem. & Met. Engr.

CHEMIST, with practical experience in iron and steel, desires position with a future; good qualification for research work; would consider entering non-ferrous field; neat, accurate and dependable; highest references for integrity; New York or vicinity. PW-200, Chem. & Met. Engrg.

CHEMIST assistant, age 25, graduate, laboratory, plant experience; will consider anything. PW-176, Chem & Met. Engrg., Old Colony Bldg., Chicago.

CHEMIST, experienced in manufacture, coating and drying of photographic emulsions for film and paper; university graduate. PW-192, Chem. & Met. Engrg.

CHEMIST, inorganic, laboratory and plant experience, desires position; present employers discontinue operations Jan. 1. PW-193, Chem. & Met. Engrg.

CHEMIST, graduate, age 28, married; four years' combined plant and laboratory experience along analytical metallurgical, microscopical and electrochemical lines. PW-160, Chem. & Met. Engrg., Real Estate Trust Bldg., Philadelphia.

ELECTRIC furnace expert and experienced works executive, a graduate in electicity, engineering and chemistry from Union and the M. I. T., desires position offering greater opportunities in a similar field; age 30, unmarried; at present engaged as metallurgist and works manager of ferro alloys plant. PW-207, Chem. & Met. Engrg.

POSITIONS WANTED

DRAFTSMAN and designer, A-1 all-around man; 10 years' experience on mills, smelter and chemical plants. PW-211, Chem. & Met. Engrg.

ELECTROCHEMICAL engineer, technical graduate, age 32, desires change; experienced in process development, reports, supervision, metallurgy; minimum $3,300. PW-166, Chem. & Met. Engrg., Real Estate Trust Bldg., Philadelphia.

FUEL chemist, university training, desires position in Middle West; experienced in analyses of fuels, iron, steel, oils, gas, water and non-ferrous alloys; best references. PW-203, Chem. & Met. Engrg., Old Colony Bldg., Chicago.

METALLURGICAL chemist qualified to direct laboratory and heat treatment, desires position; seven years' experience in iron and steel. PW-165, Chem. & Met. Engrg., Real Estate Trust Bldg., Philadelphia.

METALLURGIST, age 29, chemical engineering graduate; four years' experience in ferrous and non-ferrous metallurgy, pyrometry, heat-treatment; expert metallographist; now in charge of important metallurgical laboratory. PW-163, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

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Chemical & Metallurgical Engineering, the American Chemical Society publications, London Journal, others, domestic and foreign. B. Login & Son, 152 East 23d Street, New York, N. Y.

WANTED

CHEMICAL & Metallurgical Engineering—Volume XI, No. 6, June, 1913. Volume XIII, Nos. 5 and 6, May and June, 1915. General Bakelite Company, Perth Amboy, N. J.

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Sulphonators wanted: Fusion tanks or large nitrators. Acid resistant metal. W-206, Chem. & Met. Engrg., Old Colony Bldg., Chicago.

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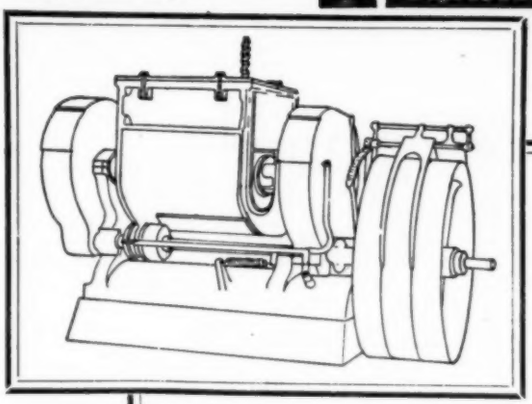

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TP 863 E—One evaporating pan 8 ft. 6 in. long x 6 ft. 6 in. wide, bottom 8 ft. long x 6 ft. 6 in. wide, end tapers 6 in toward bottom—13 in. deep.

CG 519 I—One Yaryan triple effect horizontal type evaporator, with feed and tail pump, piping, regulators, etc. Each effect 2 ft. 9 in. in. diameter carrying 48 3 ft. x 12 ft. iron tubes expanded into brass tube sheets. One Blake and Knowles wet vacuum pump and cast iron jet condenser. One Yaryan heater. 450 sq. ft. of heating surface.

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CG 519 D—One type No. 450 Kelly filter press, 450 sq. ft. of filter area. Only used a few hours. Practically new.

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CG 13 O—Eleven small Day Macaroni or shoe polish mixers, capacity 60 gals. 41½ in. long x 16 in. wide x 21 in. deep, on legs 31 in. high, holds 80 lbs. worm mixer with tight and loose pulley 18 in. diameter x 3 in. face. Outlet center of bottom 2 in. x 4 in. with quick opening valve. Galvanized iron chute to each press for unloading machine.

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CG 440 A—Six Werner & Pfleiderer mixers, 200 gals. working capacity, Type VIII, Class BB, Size 17. Actual capacity 320 gals. Inside dimensions 52¾ in. x 43¾ in. x 36 in. deep. Heights of machine to top of trough 4 ft. 1 in. Two agitator shafts, driven both ends. Jacketed; automatic dumping, with counter balance weights. 3 pulleys 34 in. x 5½ in. face—2 tight and 1 loose. 6—10 hp required. Net weight 8½ tons. Excellent condition.

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1—Tolhurst, 40-in. **Centrifugal,** rubber-coated basket, bottom discharging, lead-lined case.
1—Schaum & Uhlinger, 36-in. **Centrifugal,** copper basket.
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1—Buffalo, 6-ft. **Vacuum Crystallizer,** jacketed, agitator with bronze blades.
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1—Devine No. 11 Rotary **Vacuum Dryer,** 5 ft. dia., 33 ft. long, condenser, separator, vacuum pump.
1—Devine No. 10 Rotary **Vacuum Dryer,** 5 ft. dia., 30 ft. long, motor driven, including tubular condenser and motor vacuum pump.
1—Devine Vacuum **Drum Dryer,** 54 in. x 10 ft. 6 in., receiver, dry vacuum pump
1—Devine 6-ft. single-effect **Salting Evaporator,** salt filter, barometric condenser.
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1—Johnson 24-in. **Filter Press,** 36 chambers, 1-in. cake, closed delivery, washing.
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1—Independent 18-in. **Filter Press,** 24 chambers, wood plates and frames washing type.
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1—Buffalo **Dry Vacuum Pump,** 7 x 10 x 10, steam driven.
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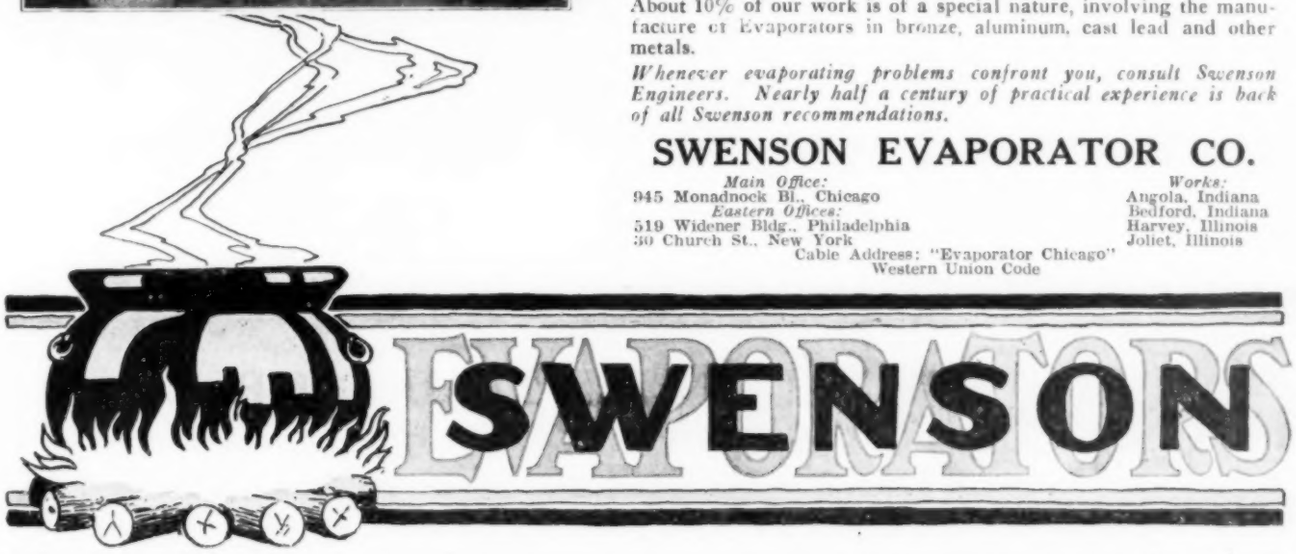

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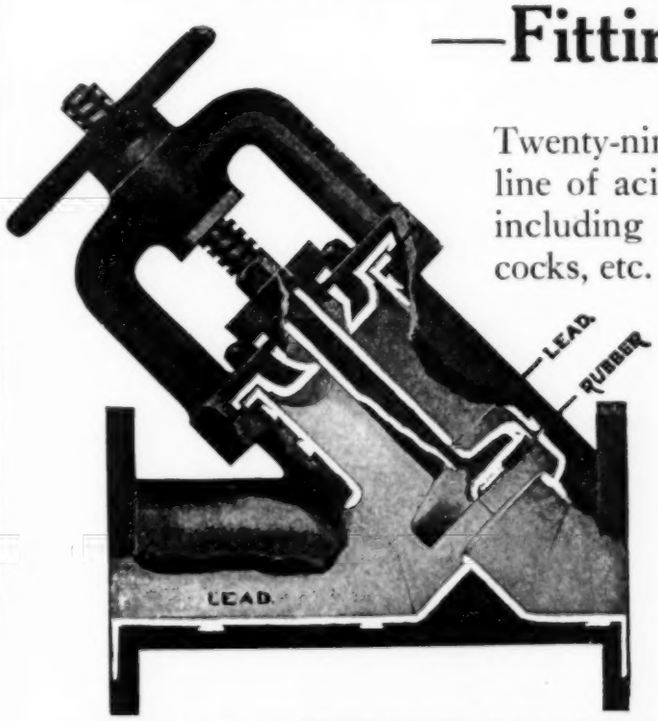

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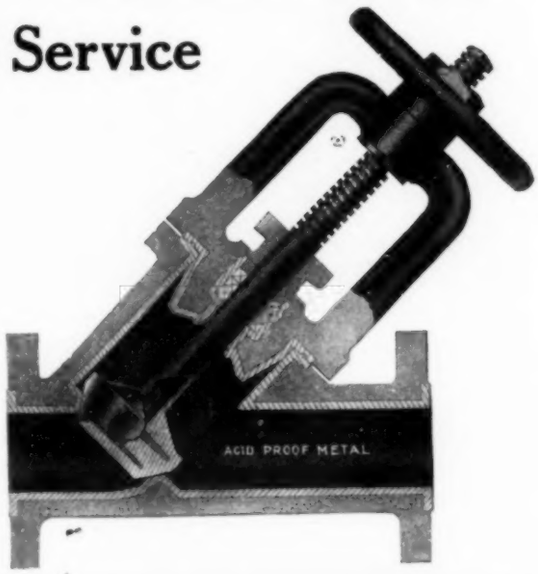

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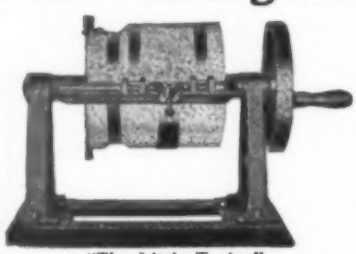

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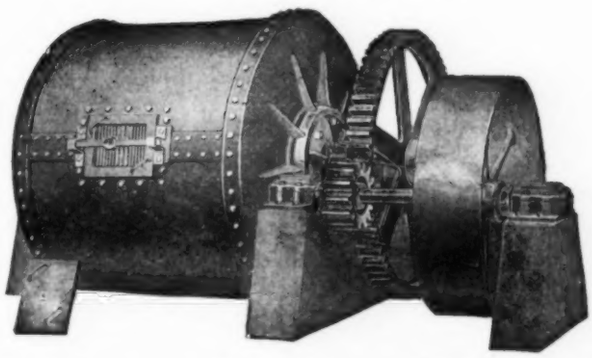

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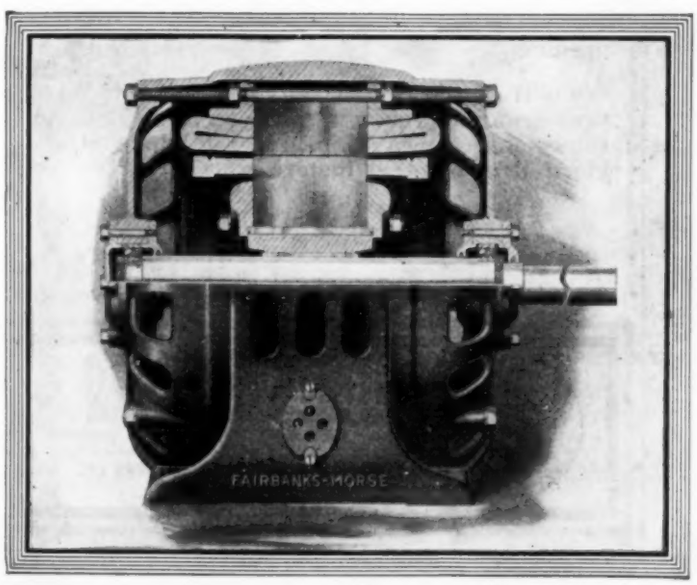

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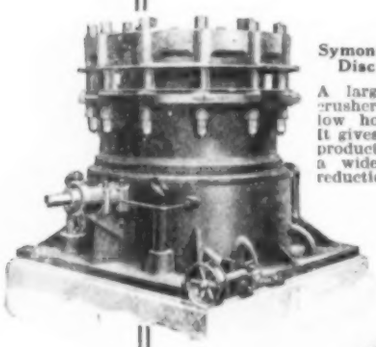

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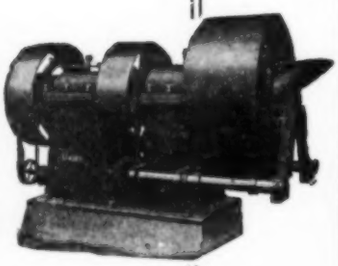

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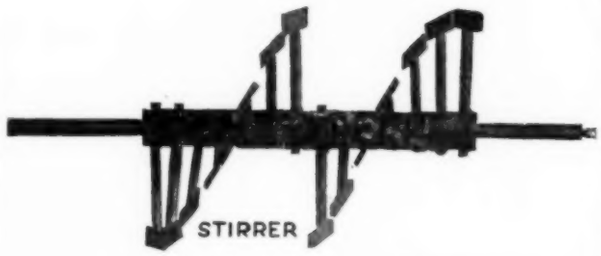

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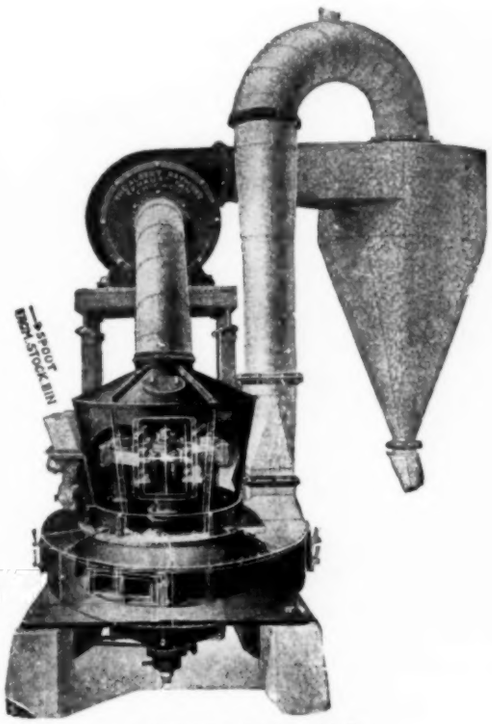

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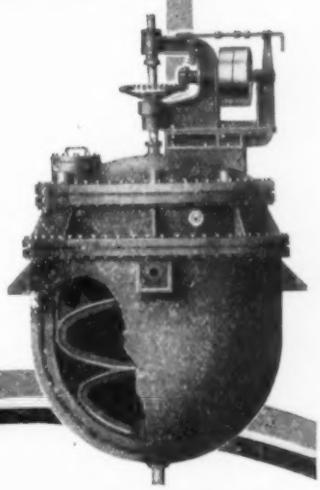

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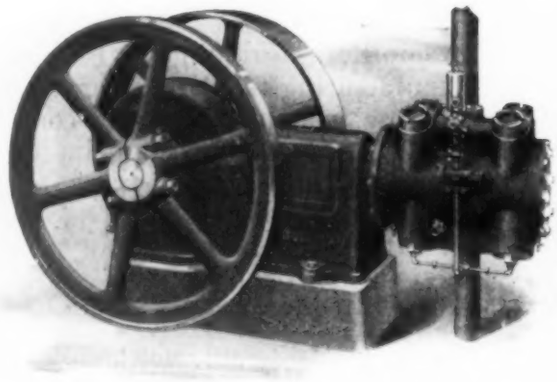
Williamsport, Pa.

Continuous Air Service



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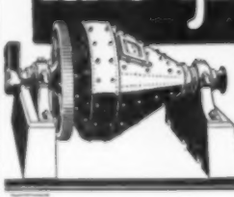

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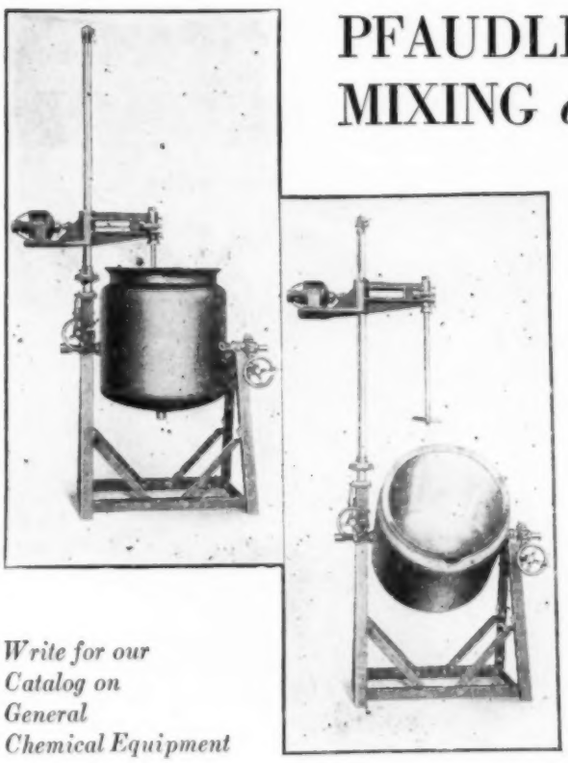

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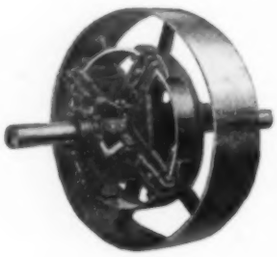

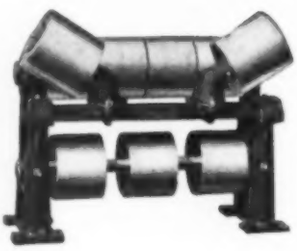

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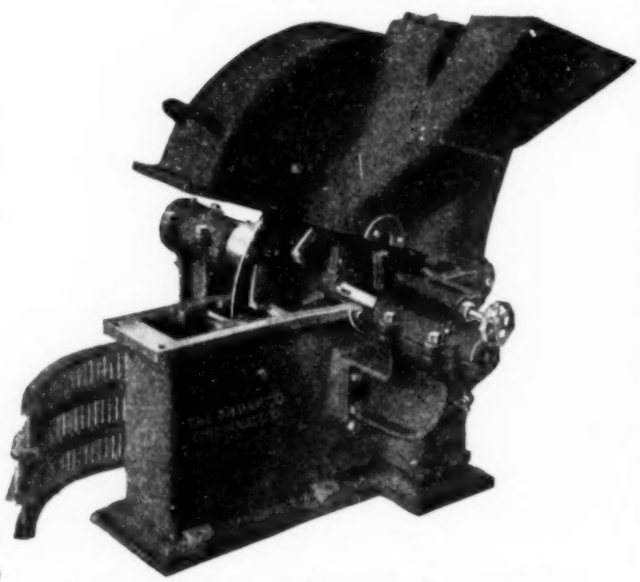

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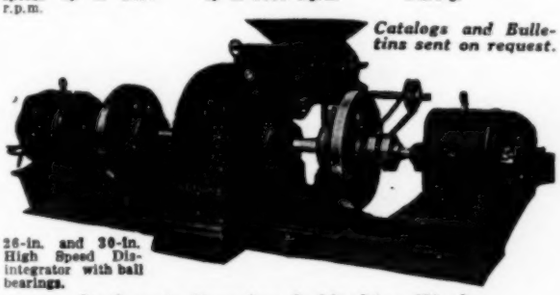

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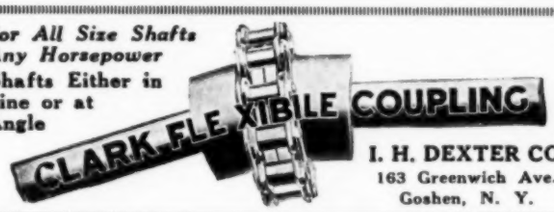

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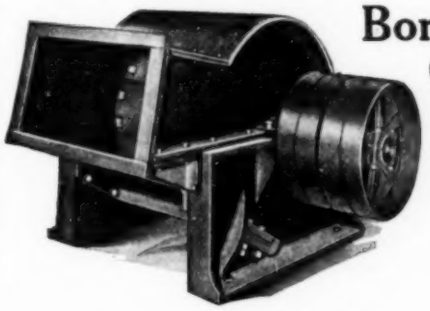

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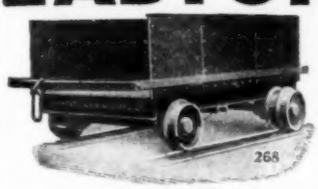

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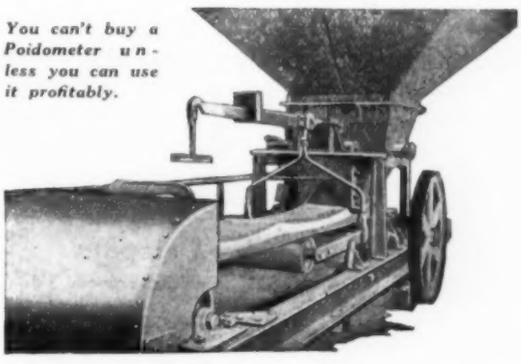

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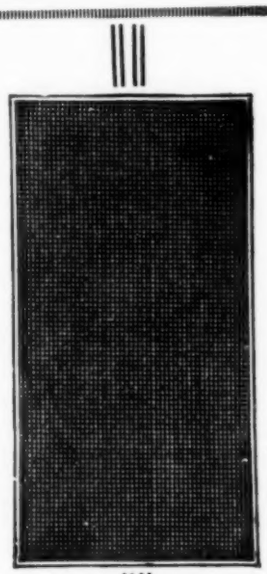

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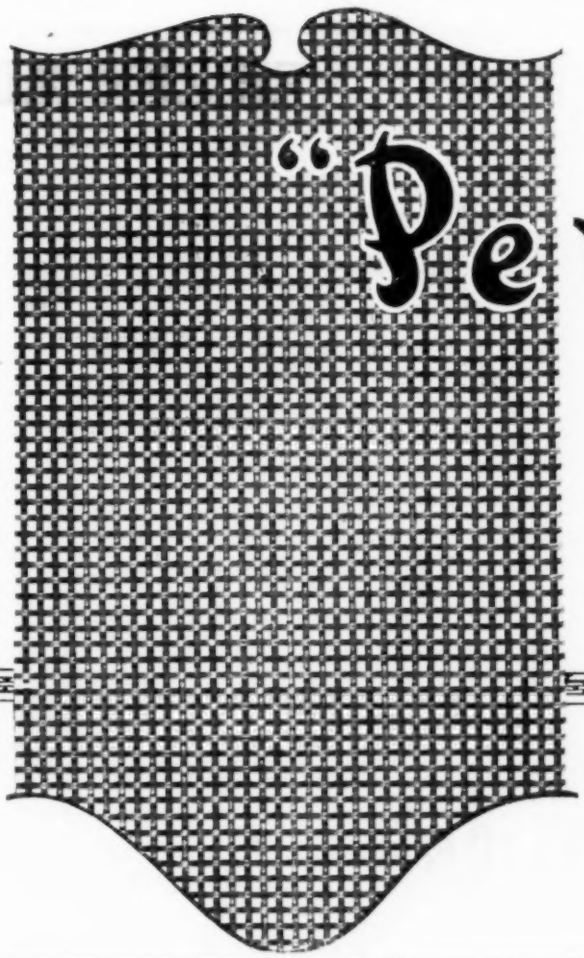

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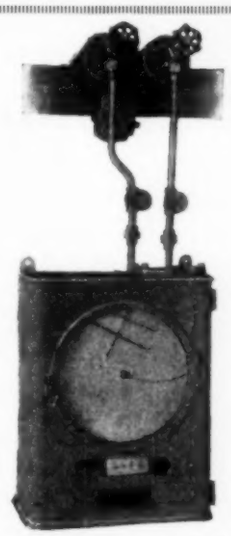

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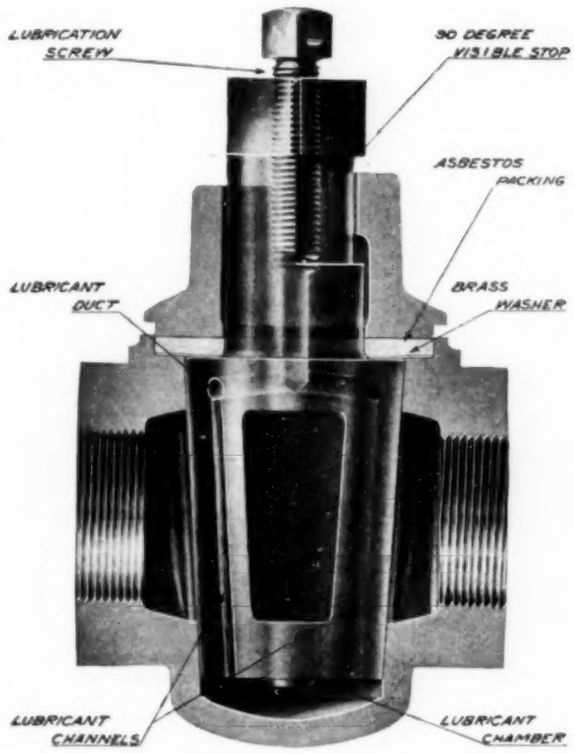

What can a valve that sticks do to *your* process?

It can always cause serious delay. It always holds up production.

Often it is worse than that—it means loss of some of your product—accidents, breakdowns, etc.

The valve that cannot be depended upon is obsolete.

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They *can't* stick; they *won't* leak!

Use them on all your air, gas and solution lines!

Write us for details *now!*

Please address nearest office.

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We specialize in
Vacuum Apparatus for all
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The Steam Actuated

RADOJET AIR PUMP

(Patented)

No moving parts, foundations,
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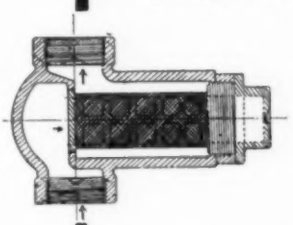

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All Requirements

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You can rest assured that he has looked over the entire field and has selected the best equipment available for his particular work.

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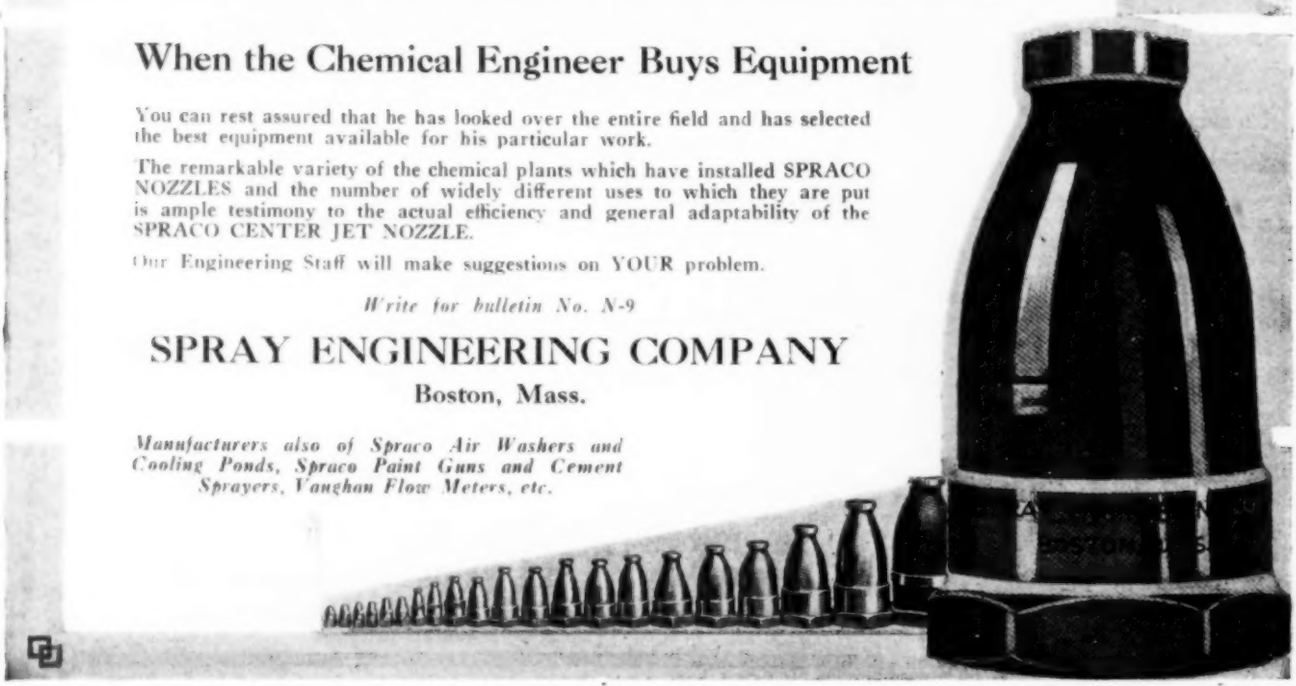

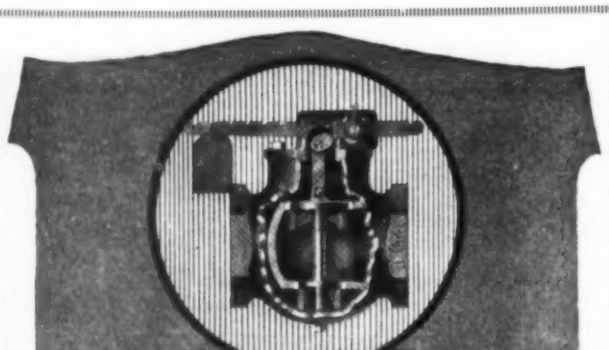

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Used in connection with our automatic control they are ideal for priming centrifugal pumps.

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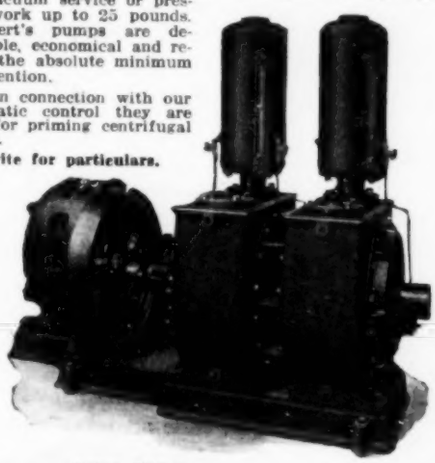

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A Highly Efficient, Single-Stage Double-Suction Centrifugal Pump For Chemical Plant Service

The AMERICAN Type "DSMD" pump is built in capacities up to 100,000 G.P.M. and for total heads up to 200 feet. Its ruggedness makes it thoroughly dependable in service. Has horizontal split shell, so that impeller and shaft can be removed without breaking connections. Double suction, enclosed impellers designed so as to overcome end thrust. Has labyrinth packing rings, reducing leakage from discharge to suction chambers to a minimum.

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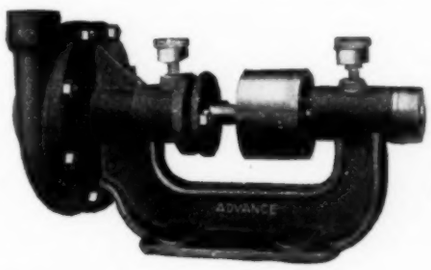

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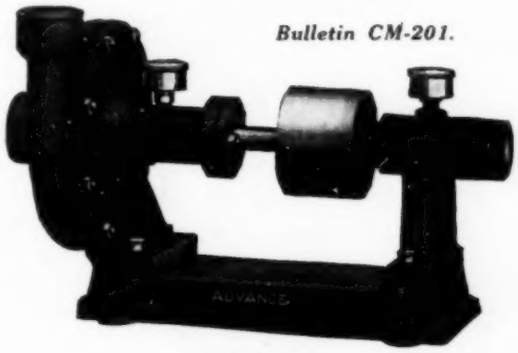
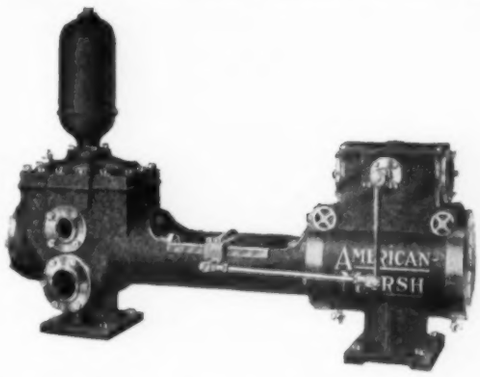


Bulletin CM-201.

Advance Pump & Compressor Co.
Battle Creek, Michigan

American-Marsh Pumps



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The designing is correct; and we always use the wood that's most suitable.

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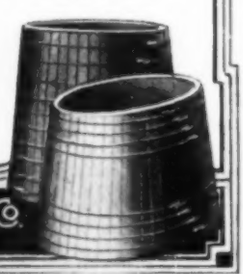

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The quality of Kalamazoo tanks is assured by the years of tank building in back of them. Fifty years has made the Kalamazoo tank what it is—*the* tank which delivers steady, uniform service, day in and day out.

We make them in any size or shape to suit your needs, as well as of any wood. Let us send you our catalog. Our stock, and our shop efficiency make prompt delivery certain.

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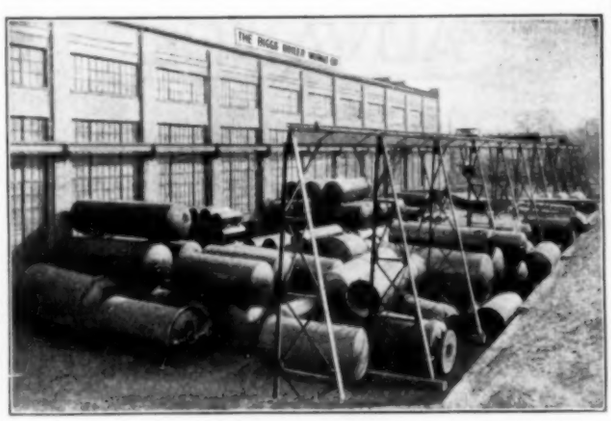
Caldwell TANKS AND TOWERS



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Let us figure on your special Tank construction Capacity 1½-in. plate.

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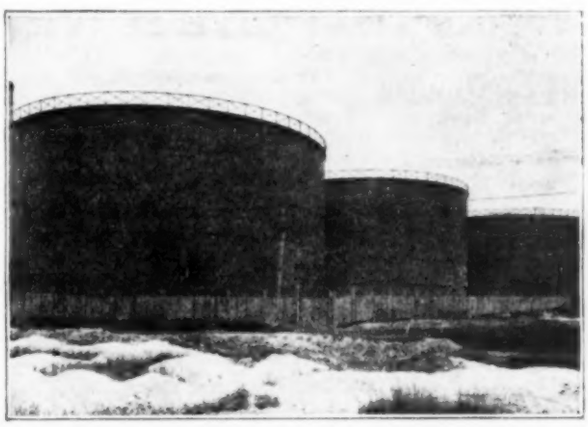

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The design of our Drive, together with the use of the ball thrust bearing makes the power requirement for operating surprisingly light.

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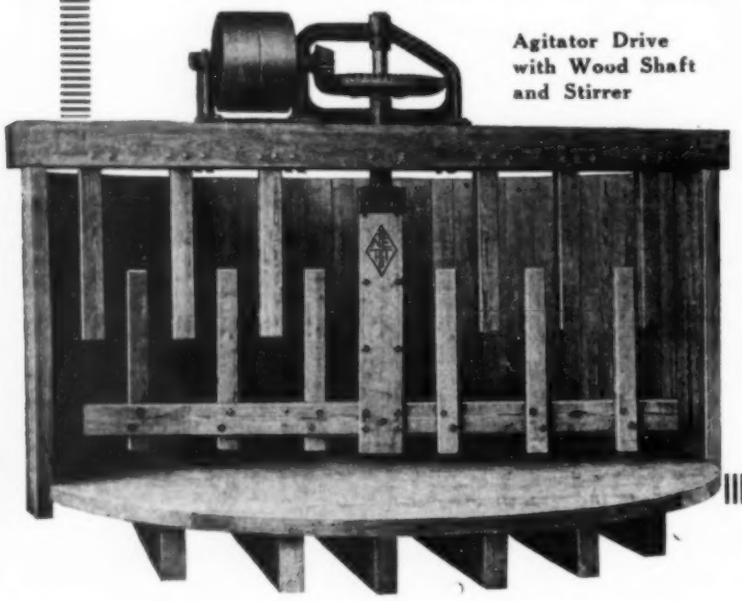

Agitator Drive with Wood Shaft and Stirrer

We have installed a number of this type that are giving wonderful satisfaction, and have designed and made installations for a wide range of work that are operating efficiently.

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Your inquiries are solicited.

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No matter what kind of a tank you want, write us for prices and any other information you may wish.

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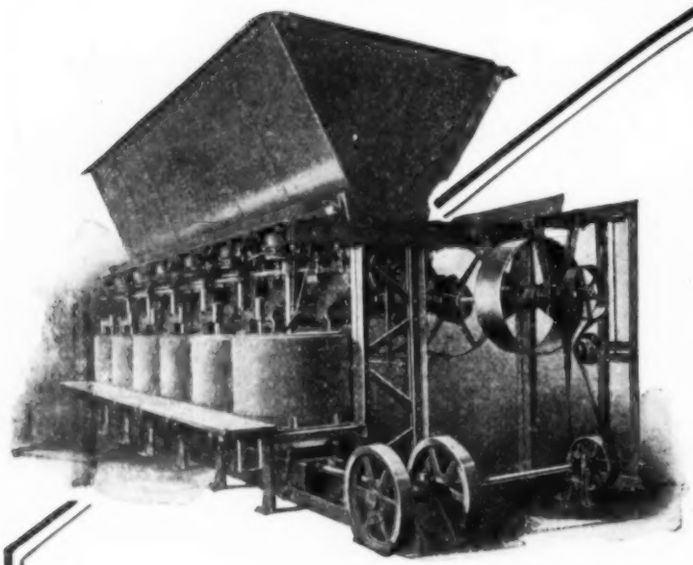

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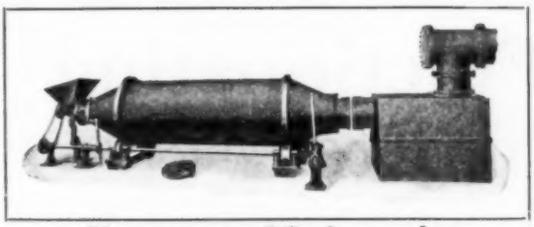

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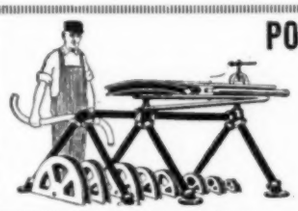

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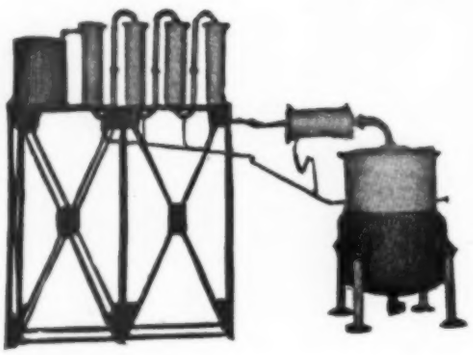

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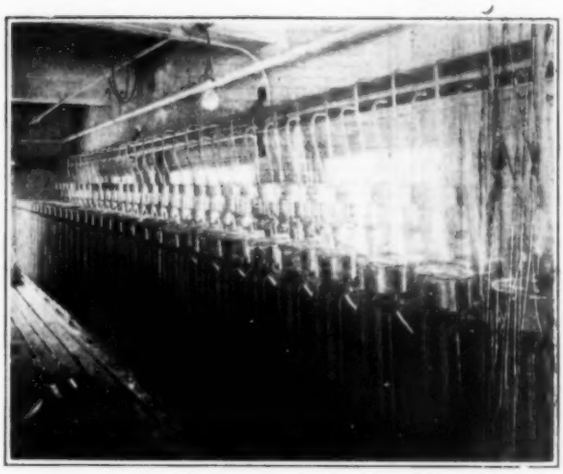

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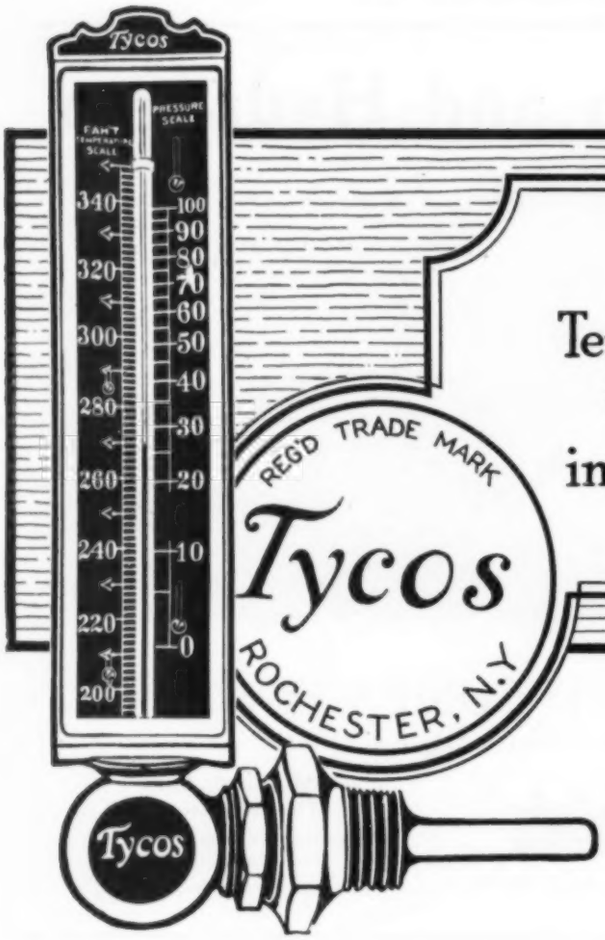

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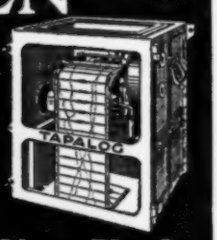

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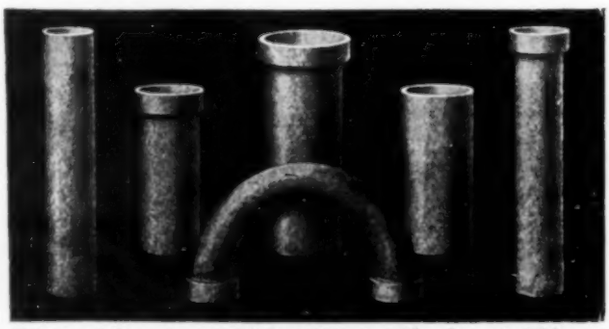

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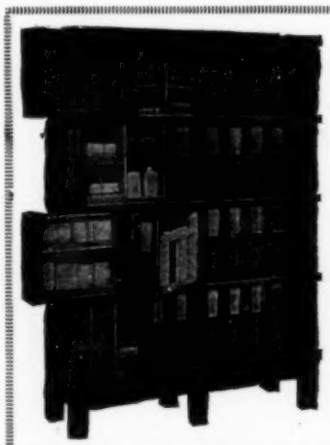

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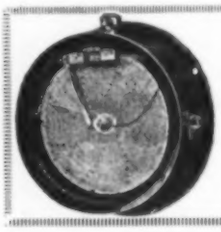

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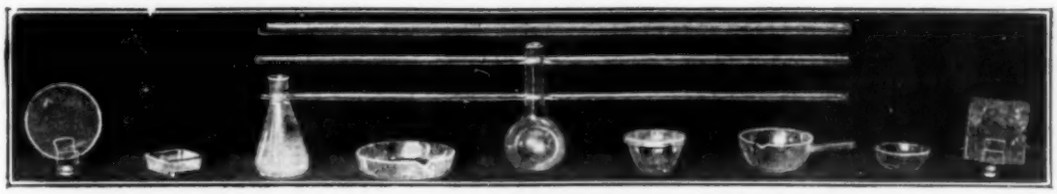

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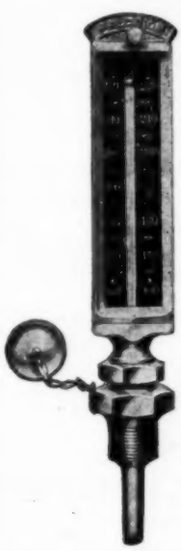

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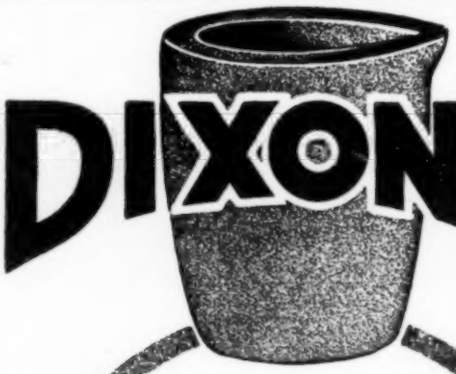

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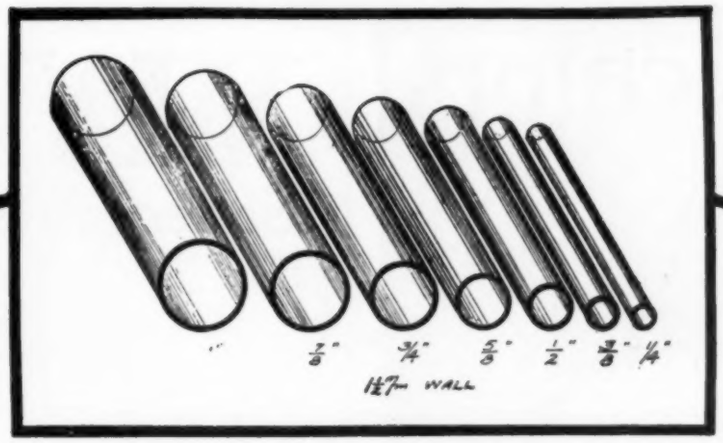

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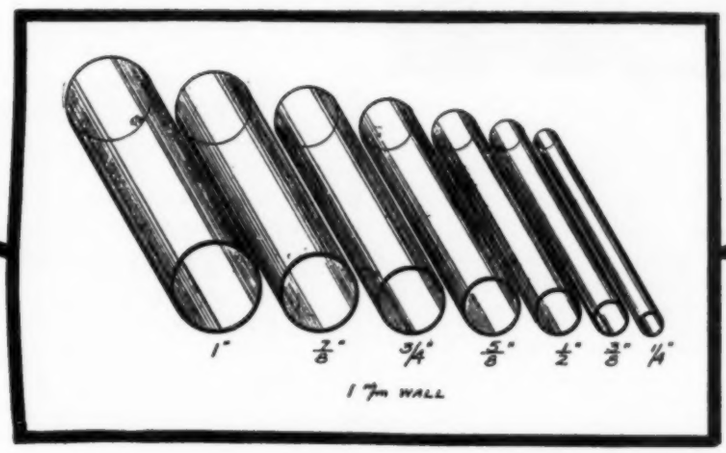

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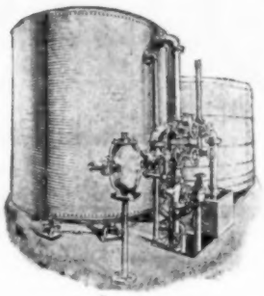

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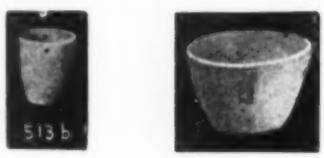

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See Professional Directory.

Autoclaves
Blaw-Knox Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Duriron Co.
Oakland Copper & Brass Wks.
Sowers Mfg. Co.
Stokes Mach Co., F. J.
Valley Iron Wks.

Bags, Fume
Best & Co., E. H.

Balances and Weights
Ainsworth, Wm., & Son.
Braun Corp., The
Braun-Knecht-Heimann-Co.
Central Scientific Co.
Eimer & Amend
Mine & Smelter Supply Co.
Schaar & Co.

Barometric Condensers
Buffalo Fdry. & Mach. Co.

Barrels, Steel, Bilge, Apitator and Open Head
Detroit Range Boiler and Steel Barrel Co.
Petroleum Iron Works

Baskets, Dipping
Newark Wire Cloth Co.

Battery Plate and Carbon
Stackpole Carbon Co.

Belt Conveyors
Bartlett & Snow Co.
Barber-Greene Co.
Caldwell, H. W., & Son
Gifford-Wood Co.
Jeffrey Mfg. Co., The
Link Belt Co.

Belting, Silent Chain
Link-Belt Co.
Morse Chain Co.

Belt Hooks
Crescent Belt Fastener Co.

Belt Lacing
Crescent Belt Fastener Co.

Belt Rivets
Crescent Belt Fastener Co.

Bins Steel and Concrete
Brown Hoisting Mchry. Co.

Bleaching Powder
Electro-Bleaching Gas Co.

Blow Cases, Stoneware Acid Proof
Knight, Maurice A.

Blowers, Fan or Positive Pressure
Abbe Engineering Co.
American Blower Co.
Beach-Russ Co.
Buffalo Forge Co.
Connersville Blower Co.
Crowell Mfg. Co.
Duriron Co.
Nash Eng. Co.
Roots, P. H. & F. M. Co.

Blowers, Rotary Positive
Roots Co., P. H. & F. M.

Blowers, Flotation
Connersville Blower Co.
Nash Eng. Co.
Roots, P. H. & F. M. Co.

Boilers, Return Tubular
Coatesville Boiler Wks.

Boilers, Water Tube
Vogt, Henry Mach. Co.

IF what you are looking for is not listed, write us : : :

Books, Technical
McGraw-Hill Book Co.

Brick, Acid Proof
Denver Fire Clay Co.
General Ceramics Co.
Harbison-Walker Refractories Co.
Knight, Maurice A.
U. S. Stoneware Co.

Brick and Clay, Fire
Crescent Refractories Co.
Denver Fire Clay Co.

Brimstone
Texas Gulf Sulphur Co.

Bronze, Titaniu, Aluminum
Titanium Alloy Mfg. Co.

Brushes Carbon
Stackpole Carbon Co.

Buckets, Clamshell & Drag Line
Blaw-Knox Co.
Brown Hoisting Mchry. Co.

Bucket Elevators
Bartlett & Snow Co.
Caldwell, H. W. & Son Co.
Gifford-Wood Co.
Jeffrey Mfg. Co., The
Link-Belt Company

Buildings Steel
Blaw-Knox Co.

Bunsen Burners
Tirrill Gas Mach. Ltg. Co.

Burners, Gas and Oil
Braun Corp., The
Braun-Knecht-Heimann-Co.
Maxon Furnace & Eng. Co.
Monarch Mfg. Works

Burners, Powdered Coal
Mine & Smelter Sup. Co.
Quigley Furnace Spec. Co.

Burners, Sulphur
Glens Falls Mach. Wks.

Cabinets, Laboratory
Schwartz Sectional System

Calorimeters
Central Scientific Co.
Eimer & Amend
Sargent, E. H., & Co.
Taylor Instrument Cos.

Carbon Projector
Stackpole Carbon Co.

Carboy Acid Lifts
Duriron Co.

Carboy Stoppers, Stoneware Acid Proof
Knight, Maurice A.

Cars, Industrial
Easton Car & Constr. Co.
Fairbanks, Morse & Co.

Cars, Mine and Ore
Easton Car & Constr. Co.
Mine & Smelter Supply Co.

Cars, Tank
General Amer. Tank Car Co.
Petroleum Iron Wks.

Cascade Basins, Acid Proof
Thermal Syndicate, Ltd.

Casseroles
Coors Porcelain Co.

Castings, Acid Proof
Bethlehem Fdy. & Mach. Co.
Buffalo Fdry. & Mach. Co.
International Nickel Co.
Pacific Foundry Co.
U. S. Cast Iron Pipe & Fdry. Co.
Valley Iron Wks.

Castings, Bronze and Brass
Titanium Alloy Mfg. Co.

Castings, Chemical
Bethlehem Fdy. & Mach. Co.
Buffalo Fdy. & Mach. Co.
Duriron Co.
Fuller-Lehigh Co.
Greenlee Foundry Co.
International Nickel Co.
Jacoby, Henry E.
Pacific Foundry Co.
Sperry, D. R., & Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Iron Wks.
Webb City & Carterville Fdry. & Mach. Co.

Castings, Iron
Buffalo Fdy. & Mach. Co.
Greenlee Foundry Co.
Jones Fdy. & Mach. Co.
W. F.
Norwalk Iron Wks. Co
Sowers Mfg. Co.

Castings, Lead
Craig Foundry Co.

Castings, Pure Copper
Titanium Alloy Mfg. Co.

Castings, Semi-Steel
Greenlee Foundry Co.

Castings, Special & Chilled
Buffalo Fdry & Mach. Co.
Fuller-Lehigh Co.
U. S. Cast Iron Pipe & Fdy. Co.

Causticizing Apparatus
Buffalo Fdry. & Mach. Co.
Dorr Company, The
Zaremba Co.

Caustic Soda and Chlorine Liquid (Electrolytic Cells for Making)
Electron Chemical Co.
Pennsylvania Salt Mfg. Co.
Warner Chemical Co.

Caustic Soda and Chlorine
Electro Bleaching Gas Co.
Solvay Process Co.

Caustic Soda & Chlorine Plants
Bleach Process Co.

Cement, Acid Proof
Anti-Hydro Waterproofing Co.
Knight, Maurice A.

Cement, Cloth
Ludlow-Saylor Wire Co.

Cement, Furnace
Dixon, Jos., Crucible Co.
Obermayer Co., S.
Quigley Furnace Spec. Co.

Cement, Iron
Obermayer Co., S.

Centrifugals
American Tool & Mach. Co.
East Jersey Pipe Co.
Hepworth, S. S., Co.
Sharples Specialty Co.
Tolhurst Machine Wks.

Chain
Ryerson, Jos. T., & Son

Chain Furnace Doors
Codd Co., E. J.

Chains, Power Transmission
Link-Belt Co.
Morse Chain Co.

Chains, Sprocket Wheel
Morse Chain Co.

Chemical Cabinets
Schwartz Sectional System

Chemical Engines
Amer. La France Fire Eng. Co.

Chemicals
Braun Co., The
Braun-Knecht-Heimann-Co
Central Scientific Co.
Cooper, Charles & Co.
Daigger, A., & Co.
Denver Fire Clay Co.
Eimer & Amend
Pennsylvania Salt Mfg. Co
Robeson, J. S.
Roessler & Hasslacher Chem. Co.
Sargent, E. H. & Co.
Schaar & Co.
Solvay Process Co.
Special Chemicals Co.
Western Chemicals, Inc.
Will Corporation

Chemists, and Chem. Engrs.
See Professional Directory

Chemists, Mfg.
Cooper, Charles & Co.
Eimer & Amend
Pennsylvania Salt Mfg. Co
Roessler & Hasslacher Chem. Co.
Solvay Process Co.

Clarifying Filters
Merrill Co.

Clarifiers
Dorr Co.
Worthington Pump & Mach. Corp.

Cloths, Mechanical
Best & Co., E. H.

Coal Tar Pitch
Barrett Co.

Coils, Copper
Whitlock Coil Pipe Co.

Collectors, Dust
Buffalo Fdry. & Mach. Co.
Research Corp.

College and Schools
Hamilton Institute, Alex.

Color Testing Equipt., Ultra Violet Ray
R.U.V. Co.

Combustion Boats
Englehard, Charles
McDanel Refractory Porcelain Co.

Combustion Equipment
Mono Corp. of Amer.

Compressors, Air or Gas
Beach-Russ Co.
Chicago Pneumatic Tool Co.
Connersville Blower Co.
Fairbanks, Morse & Co.
Nash Eng. Co.
Norwalk Iron Wks. Co.
Roots, P. H. & F. M. Co.

Concrete, Acid Resisting
Anti Hydro Water Proofing Co.

Concrete Construction
Blaw-Knox Co.

Condensers, Barometric, Surface or Jet
Devine Co., J. P.
Ingersoll-Rand Co.
Lummus Co., W. E.
Oakland Copper & Brass Wks.
Wheeler Condenser & Engrg. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Mach. Corp.

Controllers, Temperature
Crane Co.
Powers Regulator Co.

Conveyors
Portable Mach. Co.

Conveyors, Pneumatic
Guarantee Constr. Co.
Holly Pneumatic Sys.

Conveyors, Portable
Barber-Greene Co.
Brown Portable Conveying Mach. Co.
Jeffrey Mfg. Co.
Portable Machinery Co.

Conveyors, Rotary
General Elec. Co.

Copper Tubes, Seamless Drawn
Wheeler Condenser & Engrg. Co.

Coppersmithing
Oakland Copper & Brass Wks.
Ott Co., Geo. F.

Couplings, Flexible Shaft
Dexter Co., I. H.

Cranes, Locomotive
Brown Hoisting Machry. Co.
Link-Belt Company

Crucibles, Graphite
Acheson Graphite Co.
Bartley Crucible Co.
Dixon Crucible Co.

Crucibles, Industrial
Acheson Graphite Co.
Bartley Crucible Co.
Dixon Crucible Co.
Thermal Syndicate Ltd.
Warren Products Co.

Crucibles, Laboratory
American Platinum Wks.
Warren Products Co.

Crystallizers
Chemical Equip. Co.
Riter-Conley Co.

Crystalizing Pans, Cast Iron
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Oakland Copper & Brass Wks.
Mine & Smelter Supply Co.
Pfaudler Co.

Cupels
Dixon Crucible Co.

Dealers
See Searchlight Section.

Dehydrators, Centrifugal
Tolhurst Machine Wks.

Die Castings (Bronze)
Titanium Alloy Mfg. Co.

Digesters
Blaw-Knox Co.
Elyria Enameled Prod. Co.
Manitowoc Eng. Wks.
Swenson Evaporator Co.

Disintegrators
Jeffrey Mfg. Co., The
Stedman's Fdry. & Mach. Wks.

Distilleries for Industrial Alcohol
Lummus Co., The W. E.

Distilling Machinery & Apparatus
Amer. Chem. & Sugar Mach. Co.
Barnstead Still & Sterilizer Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Duriron Co.
Elyria Enameled Prod. Co.
Eimer & Amend
Koven, L. O. & Bro.
Lummus Co., W. E.
Oakland Copper & Brass Wks.
Ott Co., Geo. F.
Pfaudler Co.
Sowers Mfg. Co
Stevens-Aylsworth Co.
Stokes Mach. Co., F. J.
Swenson Evaporator Co.
Zaremba Co.

Doors, Chain Furnace
Codd, E. J., Co.

Drills, Rock and Air
Chicago Pneumatic Tool Co.

Drills, Portable and Electric
Chicago Pneumatic Tool Co.

Drives, Silent Chain
Link-Belt Co.
Morse Chain Co.

Drop Forge Fittings
Vogt Mach. Co., Henry

Drums, Steel
Detroit Range Boiler and Steel Barrel Co.
Devine Co., J. P.
Petroleum Iron Wks.

Dry Cell Filler
Acheson Graphite Co.

Dryers, Centrifugal
East Jersey Pipe Co.
Elmore, G. H.
Sharples Specialty Co.
Tolhurst Machine Wks.

Dryers, Vacuum
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Jacoby, Henry E.
Stokes Mach. Co., F. J.

Drying Mach. and Apparatus
American Blower Co.
American Process Co.
Bartlett & Snow Co.
Bay City Iron Co.
Buckeye Dryer Co.
Buffalo Forge Co
Buffalo Fdry. & Mach. Co.
Christie, L. R.
Fleisher, W. L. & Co.
Fuller-Lehigh Co.
Koven, L. O., & Bro.
Manitowac Eng. Wks.
Perry & Webster
Phila. Drying Mach. Co.
Proctor & Schwartz, Inc.
Redfield Mechanical Co.
Ruggles-Coles Eng. Co.
Stokes Machine Co., F. J.
Swenson Evaporator Co.
Vulcan Iron Works

Duriron
Duriron Co.

Dust Collecting Systems and Engineers
Guarantee Constr. Co.
Holly Pneumatic Sys.
Paxson Co., J. W.
Raymond Bros. Imp. Pul. Co.
Research Corp.

Dynamos and Motors
Jantz & Leist Elec. Co.

Ejectors or Steam Syphons
Duriron Co.

Electrical Precipitation
Research Corp.

Electric Lanterns
Federal Electric Co.

Electric Testing Sets
American Transformer Co.

Electric Tools, Portable
Chicago Pneumatic Tool Co.

Electrides, Carbon
Republic Carbon Co.
Stackpole Carbon Co.

Electrodes, Graphite
Acheson Graphite Co.

Electrolytic Cells
Electrolabs, Inc.
Electron Chemical Co
Warner Chemical Co.

Electrolytic Oxygen & Hydrogen Generators
Electrolabs, Inc.

Electroplating Dynamos; Supplies
Jantz & Leist Elec. Co.

Electroplating Salts
Roessler & Hasslacher Chem. Co.

Enameled App., Acid Resisting
Elyria Enameled Prod. Co.
Pfaudler Co.

Engineers, Chemical, Consulting, Analytical Industrial
See also Prof. Directory.
Amer Industrial Eng. Co.
Booth Elec. Furnace Co.
Fleisher, W. L., & Co.
General Machine Co.
Guarantee Constr. Co.
Industrial Furnace Corp.
Koppers Co., The
Oakland Copper & Brass Wks.
Uehling Instrument Co.
Widney Test Labs.

Engineers, Combustion
Combustion Eng. Corp.
Foxboro Co., The
Green Engineering Co.
Improved Equipment Co.
Uehling Instrument Co.

IF what you are looking for is not listed, write us : : :

Engineers, Construction
Industrial Furnace Corp.
Koppers Co., The
Research Corp.

Engineers, Furnace
Booth Electric Furnace Co.
Hagan, Geo. J., Co.
Industrial Furnace Corp.

Engineers (Testing)
Widney Test Labs.

Engines, Gas and Gasoline
Chicago Pneumatic Tool Co.

Engines, Oil
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Engines, Steam and Hauling
Vulcan Iron Works

Ether Generating Plants
Lummus Co., The W. E.

Evaporating Dishes
Thermal Syndicate, Ltd.

Evaporators
Blaw-Knox Co.
Buffalo Foundry & Mach. Co.
Devine Co., J. P.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Oakland Cop. & Brass Wks.
Ott Co., Geo. F.
Pfaudler Co.
Redfield Mechanical Co.
Sperry, D. R. & Co.
Swenson Evaporator Co.
Wheeler Condenser & Eng. Co.
Zaremba Co.

Exhausters, Rotary Positive Gas
Roots, P. H. & F. M. Co.

Extraction Plants, Tannins Logwood, Oil Seed, etc.
Lummus Co., The W. E.
Ott Co., Geo. F.

Extractors
Amer. Chem. & Sugar Mach. Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Koven, L. O. & Bros.
Lummus Co., W. E.
Oakland Cop. & Brass Wks.

Extractors, Centrifugal
East Jersey Pipe Co
Sharples Specialty Co.
Tolhurst Machine Wks.

Fans
Buffalo Forge Co.
Phila. Drying Machy. Co.
Proctor & Schwartz, Inc.
Raymond Bros. Impt. Pulv. Co.
Vulcan Iron Wks.

Fans, Stoneware, Acid Proof
General Ceramics Co.

Feeders
Bartlett & Snow Co.
Hardinge Co.
Jeffrey Mfg. Co., The

Felts, Mechanical
Best & Co., E. H.
Hitchcock Co., F. C.

Felts, Paper Makers
Albany Felt Co.

Felts, Woven
Best & Co., E. H.

Ferro-Alloys
Lavino E. J. & Co.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.

Filing Cabinets
Schwartz Sectional System

Filter Cloth
Albany Felt Co.
United Filters Corp.

Filter Cloths, Cotton & Wool
Best & Co., E. H.
Hitchcock Co., F. C.

Filter Cloth, Metallic
Ludlow-Saylor Wire Co.
Multi-Metal Co., Inc.
Newark Wire Cloth Co.
Tyler Co., The W. S.
United Filters Corp.

Filter Paper
Angel & Co., H. Reeve
Eimer & Amend

Filter, Porous Porcelain
Coors Porcelain Co.

Filter Presses
Bay City Iron Co.
Industrial Filtration Corp.
Johnson Co., John
Koven, L. O., & Bro.
Lungwitz, Emil E.
Merrill Co., The
Oliver Continuous Filter Co.
Patterson Fdry. & Mach. Co.
Perrin & Co., W. R.
Shriver, T., & Co.
Sperry, D. R. & Co.
United Filters Corp.

Filters
United Filters Corp.

Filters, Air
Permutit Co.
Research Corp.

Filters, Oil
Permutit Co.
United Filters Corp.

Filters, Rotary Continuous
Chalmers & Williams
Industrial Filtration Co.
Oliver Continuous Filter Co.
United Filters Corp.

Filters Suction Stoneware Acid Proof
General Ceramics Co.
Knight, Maurice A.
Chapman Eng. Co.
Flinn & Dreffein Co.
Hagan, Geo. J. Co.

Filters, Water
Hungerford & Terry
Permutit Co.
Scaife & Sons Co., Wm. B.
Stevens-Aylsworth Co.

Fire Brick
Obermayer Co., S.

Fire Extinguishers
Amer. La France Fire Eng. Co.

Flooring, Non-Slipping
Ryerson & Son, Jos. T.

Floors and Pits, Acid Resisting
Anti-Hydro Waterprfg. Co.

Flotation Blowers
Roots Co., P. H. & F. M.

Flotation Oil
Barrett Co., The

Forgings
International Nickel Co.

Formaldehyde Plants
Lummus Co., The W. E.

Foundry Supplies & Equip.
Paxson Co., J. W.

Friction Clutches
Jones Fdy. & Mach. Co., W. F.

Furnace Doors, Chain
Codd, E. J. Co.

Furnace Facings and Linings
Acheson Graphite Co.
Crescent Refractories Co.
Dixon Crucible Co.
Quigley Furnace Specialties Co.

Furnace Hoists
Brown Hoisting Mach. Co.

Furnaces, Assay
Braun Corp., The
Braun-Knecht-Heimann Co.
Denver Fire Clay Co., The

Furnaces, Brass or Aluminum Melting
Booth Elec. Furnace Co.
Detroit Elec. Furnace Co.

Furnaces, Caustic Pot
Industrial Furnace Corp.

Furnaces, Cupola F'dy
Worthington Pump & Mach. Corp.

Furnaces, Electric
Ajax Electro Thermic Corp
Booth Elec. Furnace Co.
Detroit Elec. Furnace Co.
Hamilton & Hansell, Inc
Industrial Furnace Corp.
Leavitt, C. W., & Co.
Pittsburgh Electric Furnace Corp.

Furnaces, Electric Lab'y.
Central Scientific Co.
Eimer & Amend
Electric Htg. App. Co.
Engelhard, Chas.
Hoskins Mfg. Co.
Industrial Furnace Corp

Furnaces, Heat Treating
Ajax Electro Thermic Corp
Electric Htg. App. Co.
Engelhard, Chas.
Fuller Eng. Co.
Hagan, Geo. J., Co.
Hoskins Mfg. Co.
Industrial Furnace Corp.

Furnaces, Melting Oil, Gas or Powdered Coal
Hagan, Geo. J., Co.

Furnaces, Muffle
Electric Htg. App. Co.
Hoskins Mfg. Co.
Improved Equipment Co
Industrial Furnace Corp.

Furnaces, Roasting & Smelting
Worthington Pump & Mach. Corp.

Furnaces, Sulphur
Pacific Fdry. Co.

Fused Silica
General Ceramics Co.
Thermal Syndicate, Ltd.

Fuses, Cartridge, Refillable.
Federal Electric Co.

Fuses, Electric
Federal Electric Co.

Fuses, Standard, Renewable
Federal Electric Co.

Gas Machines
Tirrill Gas Mach. Ltg. Co
Morgan Construction Co.
Koppers Co., The
Improved Equipment Co.

Gas Ovens
Smith Gas Eng. Co.

Gas Scrubbers and Washers
Bartlett Hayward Co.
Buffalo Forge Co.
Chemical Equip Co.
Research Corp.

Gas Valves
Smith Gas Eng. Co.

Gauges, Recording, Indicating, Draft, Pressure
Bailey Meter Co.
Bristol Co., The
Foxboro Co., The
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Cos.
Thwing Instrument Co.
Uehling Instrument Co.
Widney Test Labs.

Gears
Caldwell & Son Co.
Jones Fdry. & Mach. Co., W. F.
Morse Chain Co.

Generators (Oxygen and Hydrogen)
Electrolabs, Inc.

Glass Blowing
Eimer & Amend

Glassware, Chemical
Braun Corp.
Braun-Knecht-Heimann Co.
Central Scientific Co.
Eimer & Amend
Griebel Instrument Co.
Kimble Glass Co.
Will Corporation, The

Graphite
Acheson Graphite Co.
Obermayer Co., S.

Grates
Combustion Eng. Corp.

Grinders, Ore
Hardinge Co.

Hammers
Chicago Pneumatic Tool Co.

Heat Exchange Apparatus
Whitlock Coil Pipe Co.

Heater, Feed Water
Whitlock Coil Pipe Co.

Heating App. & Systems
American Blower Co.
Atmospheric Cond. Corp.
Buffalo Forge Co.
Fleisher, W. L., & Co.
Parks-Cramer Co.
Power Regulator Co.
Ruggles-Coles Eng. Co.

Heating Regulators
Powers Regulator Co.

Hoists
Fairbanks, Morse & Co.
Jones Fdry. & Mach. Co. W. F.

Hoists, Pneumatic
Chicago Pneumatic Tool Co.

Hoists, Portable
Ingersoll-Rand Co.

Hose
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Hot Water Storage Heater
Whitlock Coil Pipe Co.

Hydro-Extractors
Tolhurst Mach. Wks.

Hydrogen Generating App.
Electrolabs Co., The

Hydrogen Plants
Electrolabs, Inc.
Improved Equipment Co.
Hydrometers
Brown Instrument Co.
International Glass Co.

Instruments, Electrical and Testing
Bristol Co., The
Eimer & Amend
Hoskins Mfg. Co.
Precision Them. & Inst. Co.
Pyrolectric Instrument Co.
Schaeffer & Budenberg Mfg. Co.
Stupakoff Laboratories
Thwing Instrument Co.
Uehling Instrument Co.
Valley Iron Wks.
Widney Test Labs.
Wilson-Maulen Co.

Jackets, Paper Makers
Albany Felt Co.

Jigs
Worthington Pump & Mach. Corp.

Kettles, Cast Iron, Acid Proof
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.

Duriron Co.
Pacific Fdry. Co.
Stevens-Aylsworth Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Iron Wks.

Kettles, Enameled, Acid Proof
Elyria Enameled Prod. Co.

Kettles, Steam-Jacketed
Buffalo Fdy. & Mach. Co.
Day, J. H., Company
Devine Co., J. P.
Duriron Co.
Oakland Copper & Brass Wks.
Pfaudler Co.
Sowers Mfg. Co
Stevens-Aylsworth Co.

Kiln, Lime
Crescent Refractories Co.
Maxon Furnace & Eng. Co.
Vulcan Iron Works

Kiln, Rotary and Nodulizing
American Process Co.
Ruggles-Coles Eng. Co.
Vulcan Iron Works

Laboratory App. & Supplies
Braun Corp., The
Braun-Knecht-Heimann Co.
Daigger, A. & Co.
Denver Fire Clay Co.
Eimer & Amend
Griebel Instrument Co.
Heil Chemical Co.
Hoskins Mfg. Co.
Mine & Smelter Supply Co.
Pyrolectric Instrument Co.
Sargent, E. H. & Co.
Schaar & Co.
Thomas Co., A. H.
Tirrill Gas Mach. Ltg. Co.
Tolhurst Machine Wks.
Widney Test Labs.
Will Corporation, The

Laboratory Furniture
Schwartz Sectional System

Lacing Belt
Crescent Belt Fastener Co.

Ladles, Ferrous and Non-Ferrous
Obermayer Co., S.

Lifts, Air Jet
Bethlehem Fdy. & Mach. Co.
Lummus Co., W. E.
Monarch Mfg. Works, Inc.
Sullivan Mach. Co.

Loaders, Wagon & Truck
Austin Mach. Corp
Barber-Greene Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
Link-Belt Co.

Locomotives, Industrial
Jeffrey Mfg. Co., The
Vulcan Iron Works

Machine Tools
Ryerson, Jos. T. & Son

Machinery, Agitating
Buffalo Fdy. & Machine Co.
Day, J. H., Co.
Dorr Co., The
Johnson Co., John
New Eng. Tank & Tower Co.
Sowers Mfg. Co.

Machinery, Automatic Weighing
Schaffer Eng. & Equip. Co.

Machinery, Classifying
Dorr Co., The

Machinery, Coal Grinding
Aero Pulverizing Co.
Jeffrey Mfg. Co.
Raymond Bros. Impt. Pulv. Co.

Machinery, Conveying and Elevating
Austin Mach. Corp.
Bartlett & Snow Co.
Caldwell, H. W., & Son Co.
Gifford-Wood Co.
Holly Pneumatic Sys.
Jeffrey Mfg. Co.
Jones Fdry. & Mach. Co., W. F.
Link-Belt Company
Valley Iron Wks.

Machinery, Crushing, Grinding and Pulverizing
Abbé Engineering Co.
Aero Pulverizer Co.
Buchanan, C. G., & Co.
Chalmers & Williams
Day, J. H., Company
Fuller-Lehigh Co.
Jeffrey Mfg. Co.
Kent Mill Co.
Patterson Fdry. & Mach. Co.
Raymond Bros. Imp. Pulv. Co.
Stedman's Fdy. & Mach. Wks.
Straub Co., A. W.
Sturtevant Mill Co.
Vulcan Iron Works
Worthington Pump & Mach. Corp.

Machinery, Crushing, Grinding and Pulverizing Laboratory
Abbé Engineering Co.
Aero Pulverizer Co.
Braun Corp., The
Braun-Knecht-Heimann Co.
Jeffrey Mfg. Co.
Straub Co., A. W.
Sturtevant Mill Co.
Worthington Pump & Mach. Corp.

Machinery, Cyanide
Dorr Co., The

IF what you are looking for is not listed, write us : : :

Worthington Pump & Mach. Corp.

Machinery, Dewatering
Tolhurst Machine Wks.

Machinery, Mixing and Kneading
Austin Mach. Corp.
Bartlett & Snow Co.
Buffalo Fdry. & Mach. Co.
Day, J. H., Company
New Eng. Tank & Tower Co.
Patterson Fdry. & Mach. Co.
Sowers Mfg. Co.

Machinery, Ore Concentrating
Dorr Co., The
Kent Mill Co.
Ruggles-Coles Eng. Co.
Worthington Pump & Mach. Corp.

Machinery, Ore and Coal Handling
Austin Mach. Corp.
Barber-Greene Co.
Gifford-Wood Co.
Guarantee Constr. Co.
Sowers Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co.

Machinery, Pipe Bending
American Pipe Bending Mach. Co.

Machinery, Refrigerating
York Mfg. Co.
Vogt Mach. Co.

Machinery, Screening
Gifford-Wood Co.
Jeffrey Mfg. Co.
Tyler Co., The W. S.
Worthington Pump & Mach. Corp.

Machinery, Special
Buffalo Fdry. & Mach. Co.
Day, J. H., Company
Jones Fdry. & Mach. Co.

Machinery, Thickening and Dewatering
Buffalo Fdry. & Mach. Co.
Dorr Co., The

Machinery, Transmission
Caldwell & Son Co.
Jeffrey Mfg. Co.
Jones Fdry. & Mach. Co., W. F.
Morse Chain Co.

Machinery, Turbine
DeLaval Steam Turbine Co.

Machinery, Weighing
Schaffer Eng. & Equip. Co.
Sturtevant Mill Co.

Magnesia, Electrically Sintered
Norton Co., The

Magnesium Metal
Leavitt, C. W., & Co.

Magnetic Pulleys
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Magnetic Separators
Buchanan, C. G. Co., Inc.
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Magnets
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Manganese Ore
Lavino, E. J. & Co.

Metallurgical Engineers
See Professional Directory

Metals and Alloys
Metal & Thermit Corp.
York Alloy & Metal Co.

Metal Working Machinery
Ryerson, Jos. T., & Son

Meters, Flow, Air, Gas, Water
Bailey Meter Co.
Spray Engineering Co.

Mills, Ball, Pebble and Tube
Abbé Engineering Co.
Chalmers & Williams
International Nickel Co.
Patterson Fdry. & Mach. Co.
Worthington Pump & Mach. Corp

Mills, Emery
Sturtevant Mill Co.

Mills, Laboratory
Straub Co., A. W.

Monel Metal
International Nickel Co.
Multi-Metal Co., Inc.

Motor Trucks
Packard Motor Car Co.

Motors, Electric
Fairbanks, Morse & Co.

Muriatic Acid Plants, Stoneware Acid Proof
Knight, Maurice A.

Nitrating Kettles, Stoneware Acid Proof
Knight, Maurice A.

Nitrators, Centrifugal
Tolhurst Machine Works

Nitric Acid Plants
Buffalo Fdry. & Mach. Co.

Nozzles, Spray
American Blower Co.
Buffalo Forge Co.
Monarch Mfg. Wks., Inc.
Spray Engineering Co.

Oil & Grease Extraction Equipment
Bartlett & Snow Co.
Redfield Mechanical Co.

Oxygen and Hydrogen Generating Equipment
Electrolabs Co., The

Paint, Pigment, Graphite
Acheson Graphite Co.

Paints, Acid Proof and Technical
Toch Bros.

Pans, Vacuum
Amer. Chem. & Sugar Mach. Co.
Buffalo Fdry. & Mach. Co.
Levine Co., J. P.
Kestner Evaporator Co.
Lummus Co., W. E.
Oakland Copper & Brass Wks.
Pfaudler Co.
Sowers Mfg. Co.
Swenson Evaporator Co.
Wheeler Condenser & Engrg. Co.
Zaremba Co.

Patent Attorneys
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Penstocks, Wood
Stearns Lumber Co., A. T.

Pipe, Cast Iron
Glamorgan Pipe & Fdy. Co
U. S. Cast Iron Pipe & Fdy. Co.

Pipe, Silica Ware
General Ceramics Co.
Thermal Syndicate, Ltd.

Pipe and Fittings, Cast Iron Acid Proof
Crane Co.
Duriron Co.
Pacific Fdry. Co.
Pfaudler Co.

Pipe and Fittings, Copper
Lummus Co., W. E.
Whitlock Coil Pipe Co.

Pipe and Fittings, Fibre
Colonial Supply Co.

Pipe and Fittings Lead, Tin or Silver Lined
Cleveland Brass Mfg. Co
Lead Lined Iron Pipe Co.
United Lead Co.

Pipe and Fittings, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Pipe and Fittings, Wood
Michigan Pipe Co.
National Tank & Pipe Co
Pacific Fdry. Co.
Pacific Tank & Pipe Co

Pipe Covering Wood
Michigan Pipe Co.

Platinum Wire Sheet, Foil Crucibles, Dishes, Lab. Ware, all kinds
American Platinum Wks.
Baker & Co., Inc.
Bishop J., & Co., Plat. Wks

Pneumatic Tools
Chicago Pneumatic Tool Co
Ingersoll-Rand Co.

Porcelain Ware
Coors Porcelain Co.

Pots, Cast Iron, Acid Proof
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co
U. S. Cast Iron Pipe & Fdry Co.

Pots or Jars, Stoneware, Acid Proof
See Stoneware, Chemical

Powdered Coal Equipment
Aero Pulverizer Co.
American Industrial Eng. Co.
Fuller Eng. Co.
Raymond Bros. Imp. Pul Co.

Precipitation Processes
Merrill Co., The

Precipitators, Centrifugal
American Tool & Machine Co.

Pulleys, Magnetic
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Pulleys, Cast Iron
Jones Fdry. & Mach. Co.

Pumps, Acid or Acid Gases
Advance Pump & Comp. Co
American Well Works
Beach-Russ Co.
Blake Pump & Cond. Co.
Chemical Equipment Co.
Duriron Co.
Elmore, G. H.
General Ceramics Co.
Goulds Mfg. Co.
Lummus Co., W. E.
Nash Engineering Co.
United Lead Co.
Worthington Pump & Mach. Corp.

Pumps, Boiler Feed
American Steam Pump Co.
Blake Pump & Cond. Co.
Devine Co., J. P.

Pumps, Brine
Cameron Steam Pump Wks. Co.

Pumps, Centrifugal
Abbé Engineering Co.
American Steam Pump Co.
American Well Wks.
Cameron Steam Pump Wks. Co.
Duriron Co.
Goulds Mfg. Co.
Taber Pump Co.
Worthington Pump & Mach. Corp.

Pumps, Diaphragm
Cameron Steam Pump Wks. Co.
Goulds Mfg. Co.
Johnson Co., John

Pumps, Fire
American Well Works

Pumps, Gas or Liquid
Beach-Russ Co.
Blake Pump & Comp. Co.
Buffalo Fdry. & Mach. Co.
Chicago Pneumatic Tool Co.
Devine Co., J. P.
Fairbanks, Morse & Co.

Pump, Hydraulic
Blake Pump & Cond. Co.

Pumps, Mine
American Well Wks.
Blake Pump & Cond. Co.
Cameron Steam Pump Wks. Co.

Pumps, Piston
Cameron Steam Pump Wks.

Pumps, Rotary, Oil or Water
Blake Pump & Cond. Co.
Cameron Steam Pump Wks. Co., A. S.
Goulds Mfg. Co.
Taber Pump Co.

Pumps, Rotary, Positive
Roots Co., P. H. & F. M.

Pumps, Sand
Krogh Pump Mfg. Co.

Pumps, Steam
American Steam Pump Co.

Pumps, Stoneware, Acid Proof
General Ceramics Co.

Pumps, Triplex
Goulds Mfg. Co.

Pumps, Vacuum
American Steam Pump Co.
Blake Pump & Cond. Co.
Buffalo Fdry. & Mach. Co.
Chicago Pneumatic Tool Co.
Crowell Mfg. Co.
Devine Co., J. P.
Ingersoll-Rand Co.
Lammert & Mann Co.
Roots Co., P. H. & F. M.
Wheeler Mfg. Co., C. H.

Pumps, Wash Oil & Tar
Roots Co., P. H. & F. M.

Pumps, Water Works
Blake Pump & Cond. Co.

Pyrometer Protection Tubes
Coors Porcelain Co.
Engelhard, Charles
McDanel Refractory Porcelain Co.
Stupakoff Laboratories
Thermal Syndicate, Ltd.

Pyrometers
Bristol Co., The
Cleveland Instrument Co.
Engelhard, Charles
Hoskins Mfg. Co.
Pyrolectric Instrument Co.
Sargent, E. H. & Co.
Schaeffer & Budenberg Mfg. Co.
Stupakoff Laboratories
Taylor Instrument Co.
Thwing Instrument Co.
Wilson-Maulen Co.
Uehling Instrument Co.

Pyrometer Sheets, Graphite
Acheson Graphite Co.

Railway, Industrial and Portable
Easton Car & Constr. Co.

Ray Lamp, Ultra Violet
R. U. V. Co.

Reagent Cabinets
Schwartz Sectional System

Receivers, Stoneware Acid Proof
Knight, Maurice A.

Recording Instruments, Pressure, Temperatures, Electricity, Time
Bristol Co., The
Foxboro Co., The
Precision Therm. & Inst. Co.
Pyrolectric Instrument Co.
Schaeffer & Budenberg Mfg. Co.
Thwing Instrument Co.
Uehling Instrument Co.
Widney Test Laboratories
Wilson-Maulen Co.

Regulators, Pressure and Temperature
Bailey Meter Co.
Crane Co.
Davis Regulator Co., G. M.
Foxboro Co., The
Lummus Co., W. E.
Powers Regulator Co.

Respirators
Amer. La France Fire Eng Co.
Multi-Metal Co., Inc.

Retorts, Graphite
Bartley Crucible Co.

Retorts, Vertical
Buffalo Fdry. & Mach. Co.

Rivets, Belt
Crescent Belt Fastener Co.

Rolls, Crushing
Jeffrey Mfg. Co.

Safety Devices
Amer. La France Fire Eng. Co.

Sample Cabinets
Schwartz Sectional System

Scales, Conveyor
Schaeffer Eng. & Equip. Co.

Scales, Weighing
Fairbanks Morse & Co.
Sturtevant Mill Co.

Screens
Newark Wire Cloth Co.
Patterson Fdry. & Mach. Co.
Sturtevant Mill Co.

Screens, Chain
Codd Co., E. J.

Screens, Mining
Ludlow-Saylor Wire Co.

Screens, or Cloth, Fertilizer
Ludlow-Saylor Wire Co.

Screens, Wire, Brass, Copper, Steel, etc.
Ludlow-Saylor Wire Co.
Multi-Metal Co., Inc.
Tyler Co., The W. S.

Second Hand Equipment
See Searchlight Section.

Separators Air
Raymond Bros. Imp. Pulv. Co.

Separators, Centrifugal
American Tool & Machine Co.
Sharples Specialty Co.
Tolhurst Mach. Wks

Separators, Inclined Vibrating Screen
Sturtevant Mill Co.
Tyler Co., The W. S.

Separators, Magnetic
Ding's Magnetic Sep. Co.
Magnetic Mfg. Co.
Paxson Co. J. W.
Multi-Metal Co., Inc.
Newark Wire Cloth Co.

Sinks, Laboratory, Stoneware
Knight, Maurice A.
Merrill Co., The

Soda, Ash
Solvay Process Co.

Solvent Recovery App.
Lummus Co., W. E.
Oakland Copper & Brass Wks.

Specimen Cabinets
Schwartz Sectional System

Spiegeleisen
Lavino, E. J., & Co.

Spray Systems
Chemical Equipment Co.
Spray Engineering Co.

Sprockets, Compensating
Morse Chain Co.

Sprockets, Silent Chain
Jones Fdry. & Mach. Co.
W. F.
Morse Chain Co.

Steam Jacketed Kettles
Sowers Mfg. Co.

Steel, High Speed
Ryerson, Jos. T. & Son
Standard Alloys Co.

Steel Merchants
Ryerson, Jos T., & Son

Steel Plate Construction
Chicago Bridge & Iron Wks.
Pittsburgh-Des Moines Steel Co.
Sharpsville Boiler Wks.

IF what you are looking for is not listed, write us : : :

Sterilizers, Ultra Violet Ray
R. U. V. Co.

Stirrers, Acid Proof
Acheson Graphite Co.
Duriron Co.
Ryerson, Jos. T., & Son

Stokers
Babcock & Wilcox Co.
Combustion Eng. Corp.
Green Engineering Co.
Hagen, Geo. J., Co.

Stoneware, Acid Proof Chem.
Knight, Maurice A.

Stoneware, Chemical
Acid Proof Clay Prod. Co.
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Stopper Heads
Bartley Crucible Co.

Sulphur
Texas Gulf Sulphur Co.
Union Sulphur Co.

Sulphur, Flower of
Western Chemicals, Inc.

Sulphuric Acid Plants
Buffalo Fdry. & Mach. Co.

Superheaters
Babcock & Wilcox Co.

Syphons, Acid, Stoneware
U. S. Stoneware Co., The

Tachometers
Schaeffer & Budenberg Mfg. Co.

Tank Cars
Gen'l Amer. Tank Car Co.

Tanks, Acid
Biggs Boiler Works Co.
Sharpsville Boiler Wks.

Tanks, Cast Iron
Buffalo Fdry. & Mach. Co.

Tanks, Copper
Lummus, Co., W. E.

Tanks, Cyanide
Pacific Tank & Pipe Co.
Stearns Lumber Co.

Tanks, Jacketed
Biggs Boiler Works Co.

Tanks, Lead Lined, Acid Proof
Hauser-Stander Tank Co.
New Eng. Tank & Tower Co.
Oakland Copper & Brass Wks.
Stearns Lumber Co.
United Lead Co.

Tanks, Oil
Biggs Boiler Works Co.
Pittsburgh-Des Moines Steel Co.
Riter-Conley Co.
Sharpsville Boiler Wks.

Tanks, Pressure
Biggs Boiler Works Co.

Tanks, Steel
Biggs Boiler Works Co.
Caldwell, W. E., Co.
Chicago Bridge & Iron Wks.
Coatesville Boiler Wks.
Detroit Range Boiler and Steel Barrel Co.
Manitowac Eng. Wks.

Tanks or Vats, Stoneware
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Tanks, Storage
Biggs Boiler Works Co.

Tanks, Wood
Atlantic Tank & Barrel Co.
Caldwell, W. E. Co.
Corcoran, Inc., A. J.
Hauser-Stander Tank Co.
Kalamazoo Tank & Silo Co.
National Tank & Pipe Co.
New Eng. Tank & Tower Co.
Pacific Fdry. Co.
Pacific Tank & Pipe Co.
Stearns Lumber Co.
Woolford Wood Tank Co., G.

Testing Sieve Shakers
Tyler Co., The W. S.

Thermit
Metal & Thermit Corp.

Thermometers
Bristol Co., The
Precision Therm. & Inst. Co.
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Co.

Tile, Acid Proof
Knight, Maurice A.

Titanium
Titanium Alloy Mfg. Co.

Titanium Ores
Titanium Alloy Mfg. Co.

Tool Steel
Standard Alloys Co.

Tourills; Cellarius, Stoneware
Knight, Maurice A.

Tower Packing, Stoneware
Knight, Maurice A.
U. S. Stoneware Co.

Towers, Acid
Duriron Co.

Towers, Stoneware
General Ceramics Co.
U. S. Stoneware Co.

Towers, Condensing or Absorbing, Stoneware.
Knight, Maurice A.

Towers, Steel
New Eng. Tank & Tower Co.

Towers, Water Cooling
Wheeler Mfg. Co., C. H.

Transformers
American Transformer Co.

Transformers, Special and Precipitation Process
American Transformer Co.

Transits
Ainsworth, Wm. & Son

Transmission, Silent Chain
Morse Chain Co.

Trucks, Motor
Packard Motor Car Co.

Tubes, Brass and Copper, Seamless Drawn
Wheeler Condenser & Engrg Co.

Tubes, Iron & Steel
Ryerson, Jos. T., & Son

Tubing, Cotton & Woolen
Best & Co., E. H.

Tungsten Metals
Lavino, E. J. & Co.

Turbo Blowers
Ingersoll-Rand Co.

Turntables, Industrial Ry.
Easton Car & Constr. Co

Uranium Alloys
Standard Alloys Co.

Vacuum Stills
Lummus Co, The W. E.

Valves and Cocks, Metal Acid-Proof
Chemical Equip. Co.
Cleveland Brass Mfg. Co
Crane Co.
Duriron Co.
Johnson Co., John
Merrill Co., The
Pacific Fdry. Co.
United Lead Co.

Valves and Cocks, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Valves and Fittings, Fibre
Colonial Supply Co.

Vanadium Alloys
Standard Alloys Co.

Vats, Metal, Acid Proof
Duriron Co.

Vats, Wood
Atlantic Tank & Barrel Co
Hauser-Stander Tank Co.
New Eng. Tank & Tower Co
Pacific Tank & Pipe Co.
Woolford Wood Tank Co., G

Ventilator or Car Cloth
Ludlow-Saylor Wire Co

Wagon Loaders
See Loaders, Wagons & Truck

Washers, Cast Iron
Lummus Co., W. E.

Washers, Chemical
Lummus Co., W. E.

Water Purification, Softening and Rectification
Barnstead Still & Sterilizer Co.
Hungerford & Terry, Inc.
Permutit Co.
Scaife & Sons, W. B.
Standard Water Systems Co

Water Tube Boilers
Babcock & Wilcox Co.

Welding Materials
Acheson Graphite Co.
Metal & Thermit Corp.

Whizzers
Tolhurst Machine Works

Wire Cloth
Ludlow Saylor Wire Co
Multi-Metal Co., Inc.
Newark Wire Cloth Co.
Tyler Co., The W. S.

Wood Alcohol Refineries
Lummus Co., W. E.

Wood Distillation Plants
Devine Co., J. P.
Lummus Co., W. E.
Manitowac Eng. Wks.
Oakland Copper & Brass Wks
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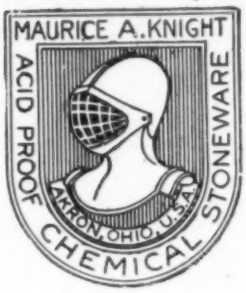

MAURICE A. KNIGHT

Manufacturer of

Acid Proof Chemical Stoneware

Acid Brick, Special Ware and Pipe

Office and Factory, Kelly Avenue

East Akron, Ohio

Preface

This folder is not to be taken as a full catalogue or as a complete list of what we make, but more in the light of a guide to the possibilities of design of Acid-Proof Chemical Stoneware apparatus, which can be made in any shape or design mechanically possible.

There is very little "stock" or "standard" apparatus in Chemical Stoneware, inasmuch as individual requirements are so diversified as to make the carrying in stock of a varied line well nigh prohibitive, consequently, only such materals, as for instance: Acid-Proof Brick, Tower Packing, Pitchers, Small Jars, Carboy Stoppers, Faucets, and standard lengths and bores of pipe and fittings, are regularly carried in stock. For that reason, over 90% of our entire production is to order from customer's blueprints or specifications.

Making Chemical Stoneware to your order is no more expensive than were it obtained from "stock," as we do not make our products on the "mass production" principle, but each piece, whether stock or to order, is handled and made individually.

For the above reasons it is of course next to impossible to issue a price list or discount sheet, so instead, we ask you to submit your problems or requirements, either in the form of a description taken from the folder, or a rough sketch or blueprint, with measurements, showing exactly what will best suit your needs, on which we will promptly and cheerfully quote best prices and shipments.

All shipments are made F.O.B. Akron, Ohio, and our terms to all responsible concerns are: Less 1% cash in 10 days, or 30 days net from date of invoice. No material of either regular or special design will be taken back for credit, unless due to errors on our part, by special arrangement, or due to the material not being up to our Guarantee.

In this folder will be found various explanatory and instructive articles on the subject of Chemical Stoneware, its uses and limitations. As they are written in the hope of being of service to you, we ask your kind indulgence in the reading thereof.

M. A. Knight

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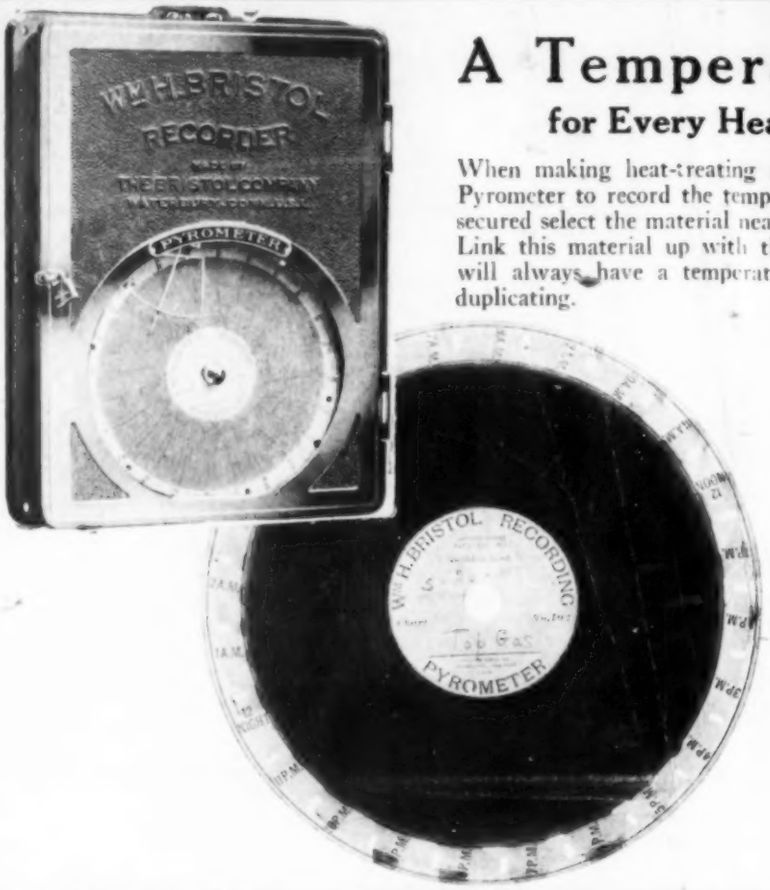
The above is a copy of the "Preface" on page one. It contains information of interest subject of Chemical Stoneware—as you will also find on the pages to follow.



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